(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

OCTOBER, 1904.

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## ECONOMICAL TRAIN OPERATION.

BY G. R. HENDERSON.

### PART I.

In the AMERICAN ENGINEER of June last appeared a number of letters from operating officials of important American railroads, which were brought out by an inquiry from this journal as to whether the present large locomotives were being overloaded, and asking what speed in their opinion was best suited for heavy and also light traffic, these terms referring to the quantity and not the quality of the business offered for transportation. The replies were in general declarations against overloading; that is, they opposed loading engines in excess of their "efficient rating," as some termed it; also the suggestion to load engines so that an average speed of 15 miles an hour could be made when the business was heavy and a less speed when the traffic was light, was largely agreed to. But here we find a stumbling block. The term "efficient rating," while no doubt meaning just what it says, is a very indefinite and intangible quantity. In fact, how many railway officials can say just what is the efficient rating of a certain locomotive over a specific division of the road? What is it that makes it efficient or inefficient? Ordinarily the safe and prompt delivery of freight or passengers is considered a mark of efficiency; but is not the latter strictly a relative term? What is prompt delivery for grain or merchandise would not be considered for a stock shipment, which must reach Kansas City or Chicago in time for a certain market. This feature of the business practically defines the necessary speed of stock trains, and also citrous fruits, but for ordinary merchandise, grain, coal or ore, there must be some method of operation which is more efficient than any other schedule that can be proposed. This is what we should term an efficient rating; but even here the efficiency may refer to the cost of operation or to the quantity of material moved, for instance, in a month. It may also occur that the most efficient rating, from a standpoint of cost, will also afford a schedule that will permit the greatest ton-mile movement in a month; or, the two phases of maximum efficiency may not be coincident. As this is one of the most important problems submitted to operating officials, we will endeavor in these articles to make clear how this matter can be studied practically, and the most efficient schedule and rating of an engine over a division discussed, both as regards cost of operation and amount of business handled.

#### OPERATING CHARGES.

In the first place, we must consider what operating charges are involved in the question under consideration. It is plain that such items as superintendence, maintenance of bridges and buildings, terminal handling of freight, etc., will not be affected in the least by the train loads assigned to the engines; also, that maintenance of track, switching charges, etc., will but slightly reflect changes in the rating of locomotives. The items that are immediately concerned in this problem may be grouped into three classes, viz.: Supplies, repairs and service. The following table gives the percentage of these items of the total operating expenses on an important overland railroad:

| | | Per cent. |
|---|---|---|
| | SUPPLIES. | |
| a. | Fuel for locomotives | 8.20 |
| b. | Water, oil, waste and miscellaneous supplies for locomotives | 1.20 |
| c. | Train supplies | 1.30 |
| | REPAIRS. | |
| d. | Repairs and renewals to locomotives | 8.00 |
| e. | Repairs and renewals to cars (freight) | 5.30 |
| | SERVICE. | |
| f. | Wages of engineers and firemen | 7.00 |
| g. | Wages of train men | 4.50 |
| h. | Wages of roundhouse men | 1.00 |
| | Total | 36.50 |

In round numbers, about one-third of the operating expenses are directly concerned in the freight train movement. No matter how we make up these trains (within reason, of course) the effect on the other two-thirds of the operating expenses will be very slight, and, for our purpose, can be left out of consideration. It should be borne in mind, however, that an improvement or reduction in these expenses of 3 per cent. would only appear as 1 per cent. gained in the total operating charges; nevertheless, the absolute amounts will be undisturbed, and $50 saved is $50 credit in both cases.

In addition to these operating expenses, the capital involved may be represented by interest charges on the locomotive and caboose, and these added to the expenses "a" to "h" will give the total expense of the movement; these interest charges we will designate by "i." We must now determine how to estimate the actual value of the several charges "a" to "i."

*a. Fuel for Locomotives.*—This is the largest item of expense, and it is also the most difficult to estimate correctly. It is greatly affected by many variables, as the price per ton, the heating value, the grade, the speed and the tonnage hauled, as well as by the proportions and condition of the engine and the skill of the engineer and fireman. The last two items are too indeterminate to consider here; but the others must be studied in their effect upon the economy of fuel. In this analysis the price will be considered as $2 per ton of 2,000 lbs., or $1 per 1,000 lbs., which, probably, is a fair average price in this country, and the grade that of Illinois bituminous, such as was used in some tests made upon the locomotive testing plant of the Chicago & Northwestern Railway several years ago by the author, and upon which tests this argument is based. The engine to be used in slow or general freight should be as heavy as the track and bridges will permit, and for grade work we will select a locomotive of the following general proportions:

CONSOLIDATION LOCOMOTIVE.

| | |
|---|---|
| Theoretical tractive force | 50,000 lbs. |
| Available tractive force | 40,000 lbs. |
| Diameter of drivers | 56 ins. |
| Area of grate | 40 sq. ft. |
| Weight of engine and tender | 150 tons |

If we consider that the fireman is able to supply the coal as fast as it is possible to burn it on the grate—that is, at a rate

of 200 lbs. per square foot per hour—we find that the engine will consume $200 \times 40 = 8{,}000$ lbs. of coal an hour. It is unlikely that an ordinary man could keep up this rate of stoking for a great number of consecutive hours; but in order to obtain the maximum work out of our locomotive we will consider that it is possible to fire at that rate. The maximum available tractive force—that is, at the circumference of the drivers—is 40,000 lbs.; but, as the speed exceeds 10 miles an hour, the boiler will not supply steam enough to follow full stroke, and the lever must be "hooked up" or an earlier cut-off produced. This cut-off must be shortened continually, as the speed increases, reducing the available tractive force, as shown by the line A-B in Fig. 1, where the ordinates represent available tractive force (A. T. F.) and the abscissae speed in miles per hour and revolutions per minute, as designated.

The line A-B is also marked "8,000 lbs. coal per hour," as it represents the maximum capacity of the engine, as governed by the quantity of fuel burned upon the grate. The concentric line marked "6,400 lbs. coal" shows the corresponding speeds and tractive forces for a rate of combustion 0.8 as great as the maximum; so also the lines designated by 4,800, 3,200 and 1,600 lbs. coal show the same data for burning rates of 0.6, 0.4 and 0.2 of the maximum, these curves having been based upon the results of the engine tests above referred to.

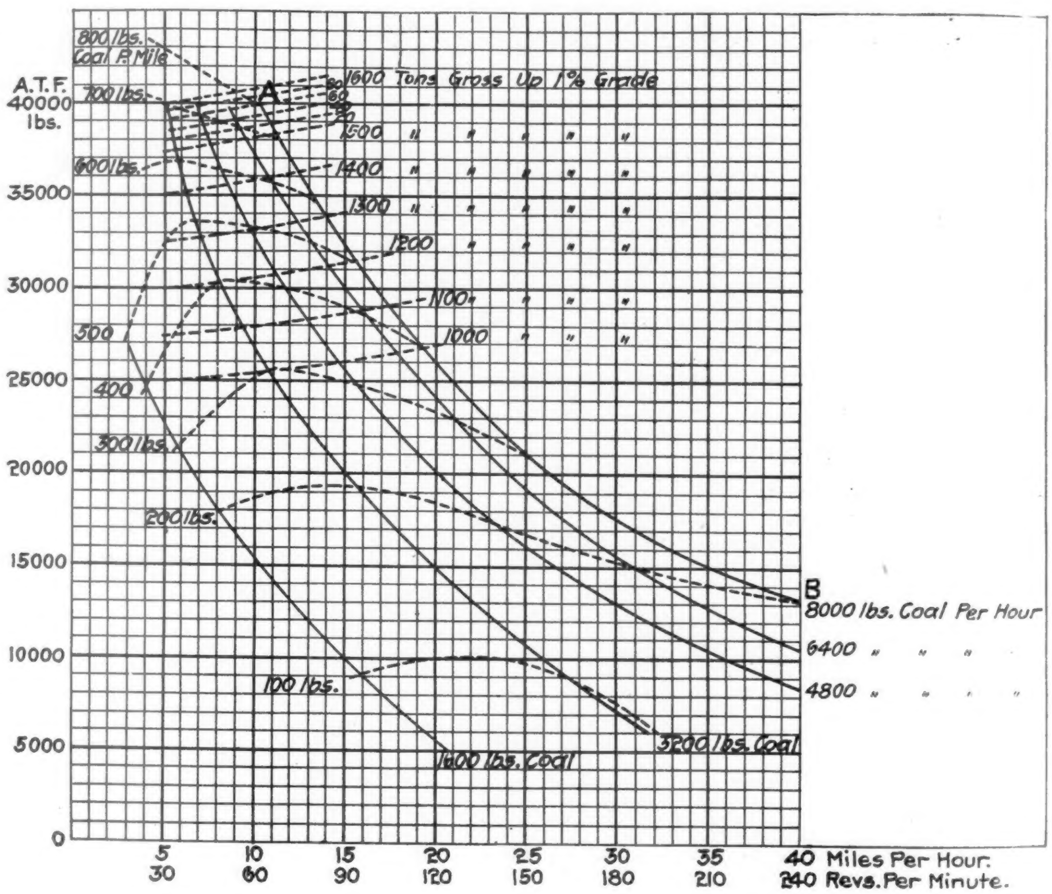



FIG. 1.—COAL CONSUMPTION OF CONSOLIDATION LOCOMOTIVE.—(150 TONS WEIGHT.)

If we divide the total coal burned per hour by the speed in miles per hour, we obtain the rate per mile; this has been done and is shown by the dotted lines marked 100, etc., to 800 lbs. per mile. The two sets of line provide us with the means of estimating the quantity of coal burned per mile or per hour for any combination of speed and tractive effort possible within the capacity of the engine; any point selected between these lines is to be interpolated. For example: At 20 miles per hour the maximum available tractice force will be 26,000 lbs., and the coal consumption 8,000 lbs. per hour, or 400 lbs. per mile. At the same speed, but with a tractive force of only 20,000 lbs., the consumption would be 4,800 lbs. an hour or 240 lbs. per mile (as seen by interpolating between the dotted lines). Also with 26,000 lbs. A. T. F. at 16 miles an hour, the rate would be 5,300 lbs. per hour or 330 lbs. per mile.

As we can now determine the fuel consumption for any tractive force and speed, we are at once put in possession of the consumption for various speeds, grades and loadings, as the tractive force depends upon these items. If we suppose that the controlling grade is 1 per cent., or 52.8 ft. per mile, we can construct on the same diagram (Fig. 1) additional curves, which will show the tractive force necessary to move various loads at different speeds. Thus a gross weight of train of 1,600 tons at 5 miles an hour up a 1 per cent. grade will require $1{,}600 \times (20 + 5) = 40{,}000$ lbs. A. T. F., and at 10 miles an hour, $1{,}600 \times (20 + 5.5) = 40{,}800$ lbs. A. T. F. We can therefore lay off the broken line marked "1,600 tons gross up 1 per cent. grade." The rest of the broken lines have been constructed in a similar manner, by calculating the total resistance under the different conditions.

From this combination we are able to read off directly the amount of coal required per mile or hour for various weights of train at the different speeds upon the 1 per cent. grade selected as the limit. Of course any other series of curves could be studied. From Fig. 1 we learn that a train of 1,600 tons gross weight could not be drawn up a 1 per cent. grade faster than 5 miles an hour with an expenditure in fuel of 700 lbs. per mile, while a train weighing 1,570 tons (only 30 tons less) could be taken up at 10 miles an hour, but with a coal consumption of 800 lbs. per mile. If we wished to make a speed of 20 miles per hour, our train must be reduced to about 960 tons gross weight, under which conditions 400 lbs. of coal will be burned per mile. It will be noticed that the dotted lines have generally their highest point on the 3,200 lbs. per hour line, which corresponds to a coal combustion of 80 lbs. per sq. ft. of grate per hour, and for any given weight of train, this rate of combustion per hour will indicate the minimum rate of coal per mile. Thus, a 1,500-ton train will use the smallest amount of coal in a given distance on a 1 per cent. grade, when run at about 5½ miles per hour, and a 1,200 ton train when operated at 9 miles an hour. This figure shows at once by simple inspection the "coal efficiency" of different train loads and speeds, but as we have stated, that is only a part of the problem.

*b. Water, oil, waste and miscellaneous supplies for locomotives.*—We saw in our statement of operating expenses that little over 1 per cent. of the total is consumed by these items, so that they may generally be grouped together without sensible error. While the water used will depend upon the tractive power exerted, the other supplies will be governed almost entirely by the mileage alone, and as water is generally a low-priced commodity, we can figure these supplies as a whole upon a mileage basis. Examination of reports of various railroads indicates that 1.5 cents per engine mile can be taken to cover these items, though in any special case it should be selected to cover the existing conditions, as should all of these hypothetical items. If the water needs treatment, the value should be increased, and if the cost of such treatment be high, it may even be advisable to consider this item separately, and in a similar manner to that of the fuel. As a rule, however, water

seldom costs over 5 cents per 1,000 gallons, and as a gallon of water requires, roughly speaking, a pound of coal for its evaporation, at this rate the cost would be only 5 per cent. of that of the coal, and it is very unlikely that it would average anything like that figure for a long division in a country fairly well watered. For this reason we have taken the cost of the engine supplies, with the exception of coal, at 1.5 cents per mile, but where necessary on account of hauling water or from other considerations which raise the cost to an abnormal figure, it may be considered separately, and as a percentage of the cost of fuel.

*c. Train Supplies.*—This cost will depend partly upon the number of cars in the train, though a large portion will be an absolute charge per train mile. As it is not likely under normal conditions of operation that there would be any very great fluctuations of train loading, we will assume this charge also at 1.5 cents per mile, which we believe is a fair figure for freight trains in this country.

*d. Repairs and Renewals to Locomotives.*—This item has usually been considered upon an engine mileage basis only, but in recent times the ton mileage basis has come to be favorably considered. It is no doubt true that a combination of both the engine and ton mileage would be the correct method for an accurate analysis of this item, but even then the ordinary variation in cost of repairs is so great between identical engines that it hardly seems worth while to work up an elaborate formula for this purpose. It is also true that a load of 1,000 tons on a 1 per cent. grade is about as severe on an engine as 2,000 tons on a ½ per cent. grade, yet in the first case the ton miles credited to the engine would be only half as great as in the second case, which demonstrates that a unit which considered the actual work done, such as the product of the tractive force and the distance, would be very much nearer the truth; but this unit would also be difficult of practical realization. After due consideration we have concluded that a rate of 8 cents per 1,000 ton miles net would cover repairs and renewals; and while it may be considered by some as too high a figure per engine mile, it must be borne in mind that renewals are also to be included in this amount.

*e. Repairs and Renewals to Freight Cars.*—This item could probably be omitted from consideration in connection with this subject, as it is supposed that there is a definite amount of traffic to be handled, and consequently a certain amount of car mileage must be made, but in order to estimate our train charges completely, a value will be assigned to it in this discussion. One half cent a car mile is probably a fair average for cost of repairs, and as the average weight of loaded cars is about 33 tons, we have $0.5 \div 33 = .015$ cent per ton mile or 15 cents per 1,000 ton miles, which is the same unit that we have used for locomotive repairs. This is almost double the rate of repairs to the locomotive on the ton mile basis, whereas the percentage of operating expenses was less for cars than for locomotives, but this was taken from the total charges and included light engine mileage, switching, etc., so that a close agreement between the two could not be expected.

*f. Wages of Engineers and Firemen.*—Owing to the different schedules of pay in existence at various points, this item must be selected in accordance with the rules in force on the division under consideration. In most cases engine men are paid the standard rate for a 100-mile run, even if a smaller distance be covered, so that if a run were 70 or 80 miles long, the pay would be the same as for 100 miles. Special arrangements cover "turn-around" points. In addition to this, some high-grade divisions allow constructive mileage of an arbitrary amount, over and above the real mileage made.

If the run be over 100 miles the men are paid usually for the additional mileage at the same rate. Delays on the road or slow runs are also subject to an extra allowance as overtime, the ordinary regulation being that if the average speed is less than 10 miles an hour between terminals, the pay shall be at the rate of 10 miles an hour. This irregular schedule has a peculiar effect upon the efficiency of a time schedule from a standpoint of wages. Thus a run less than 100 miles results in an excessive cost per mile, and a speed slower than 10 miles an hour produces the same result. If the distance traversed be over 100 miles and the average speed in excess of 10 miles an hour, the rate of pay per mile will be uniform.

In order to proceed with our study the schedule of a prominent Western road is adopted, viz.: Engineers, $4.25 and firemen, $2.75 for 100 miles or less; for runs over 100 miles, 4¼ and 2¾ cents per mile. Overtime to be allowed when the time between terminals is greater than the miles divided by 10 and at the rate of 10 miles an hour or 42.5 and 27.5 cents per hour respectively. In computing overtime, 29 minutes overtime will not be allowed; 30 minutes or more will be considered as one hour; after the first hour of overtime, one mile will be allowed for every 6 minutes additional time made.

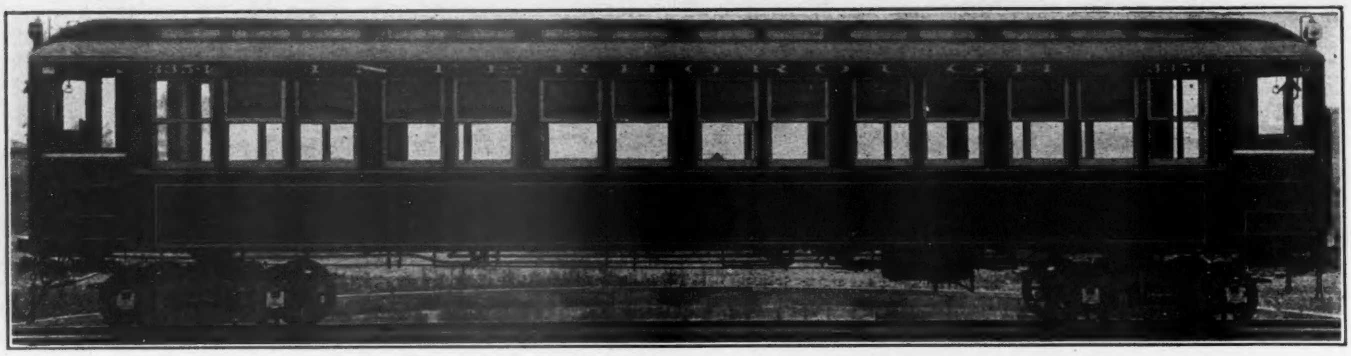
*g. Wages of Trainmen.*—The road just referred to provides the following wages for trainmen: Freight conductors, $89.70 per month, for 2,600 miles in 26 days; for excess mileage the same rate obtains, viz., 3.45 cents a mile. Overtime is allowed whenever the speed is less than 10 miles an hour, and is computed at the rate of 1 mile for each 6 minutes overtime. Freight brakemen receive $59.80 per month of 2,600 miles in 26 days, or 2.3 cents per mile for excess mileage, overtime being allowed same as for conductors. Thus we find that runs of less than 100 miles in a day or average speeds of less than 10 miles an hour cause excessive charges for service and cannot be considered efficient from a standpoint of wages either as regards the engine crew or the train crew.

*h. Wages of Roundhouse Men.*—The cost of turning locomotives is practically independent either of the mileage or ton-mileage performed. It includes the cost of cleaning fire and ash-pan, hostling, wiping and firing up. The boiler washing does depend upon the mileage to some extent, but only in a general way. Thus if the water were bad the boiler would be washed out after every trip, whether the division be 100 or 150 miles in length. There are also running repairs to be made every trip or so, such as closing rod brasses, cleaning air brake, grinding check valves, etc., and we propose to cover these charges by allowing $2 for each time that the engine is housed. While this figure may seem high, it represents about the cost of caring for large engines in the Middle West and we do not think that the amount is unreasonable for the size of engine selected for this discussion. If a territory is being computed where labor conditions suggest a reduced figure, it of course should be changed accordingly.

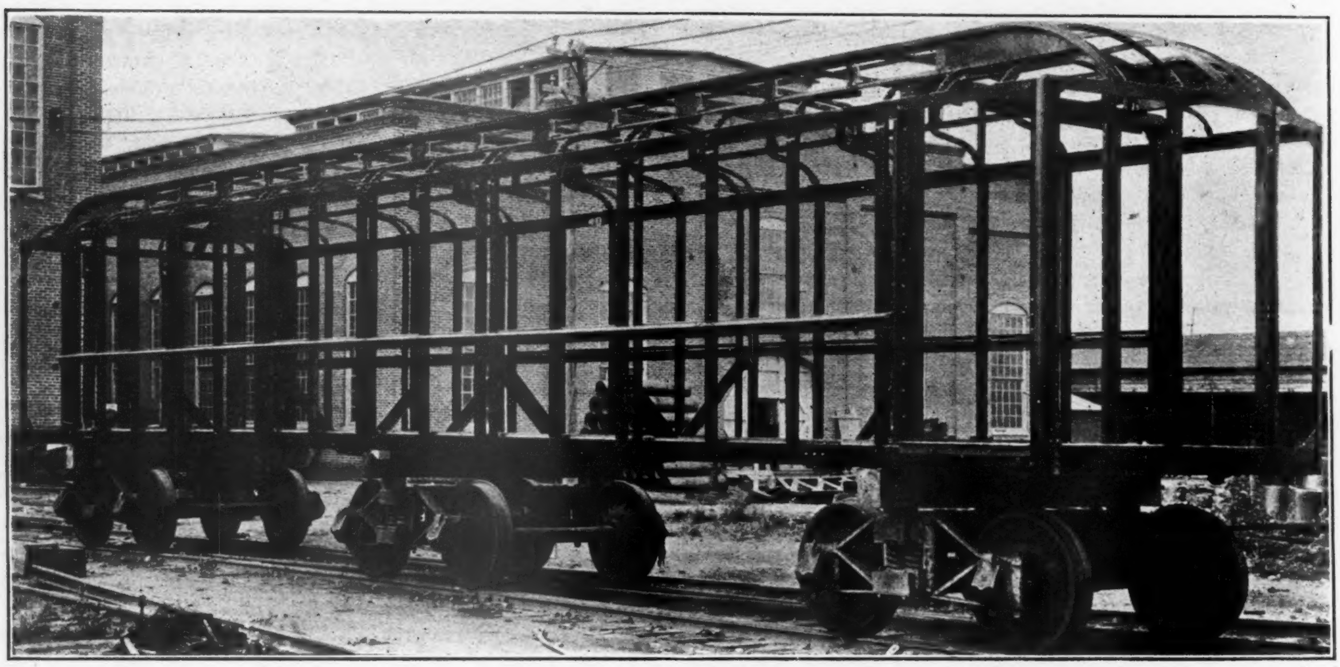
*i. Interest Charges.*—Interest is not generally considered an operating charge in railroad accounts, but it certainly has an effect upon economical train movement. Locomotives are usually purchased from a fund provided by the sale of stock or bonds, upon which interest is paid, and therefore it is perfectly reasonable to include this account in our study. The same applies to the cabooses or way-cars. Such an engine as we are considering would, with its caboose, represent perhaps an invested capital of $18,000. At 5 per cent. this would mean an interest charge of $900 a year or $\frac{900.00}{360 \times 24} = 10$ cents an hour, and this charge goes on whether the locomotive is working, standing in the roundhouse or on the side track, or is in the shop undergoing repairs. We know that engines are often valued at $10, $20 or perhaps $50 a day for rental purposes; that, however, is an entirely different matter.

*(To be continued.)*

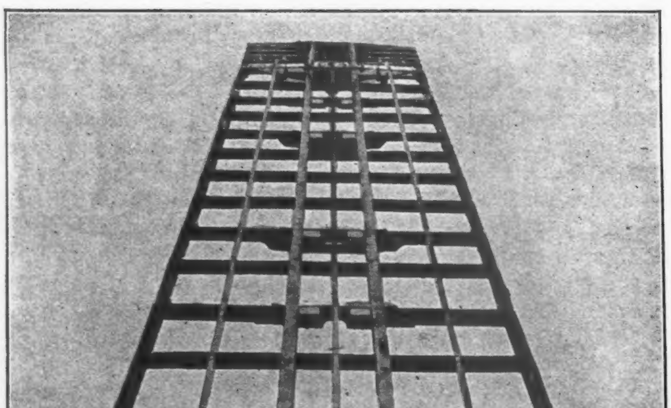
American Success in Machine Tools.—Visiting English mechanical engineers attending the recent convention in Chicago were impressed with one reason for the success of American machine tool builders. It was the fact that many of the builders concentrate their energy and attention upon one form of machine tool and thus are able to carry it to a high state of development. This also favorably affects manufacturing, because in the reproduction of a large number of similar designs the builders can afford to provide facilities which otherwise would not pay for themselves. The advantages of specialization impressed our foreign friends.



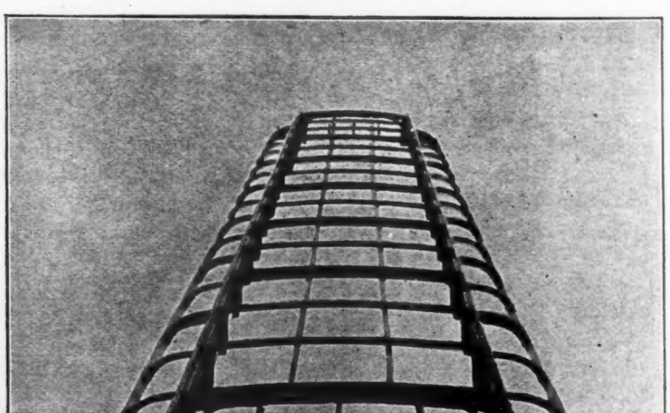
SIDE VIEW OF FINISHED CAR SHOWING ATTRACTIVE APPEARANCE.



FRAMING BEFORE SIDE PLATE IS APPLIED.

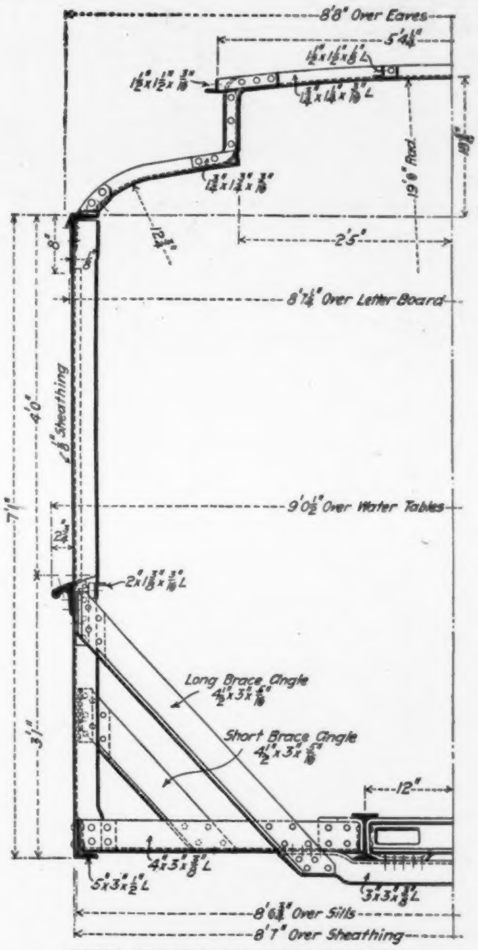


FLOOR FRAMING.

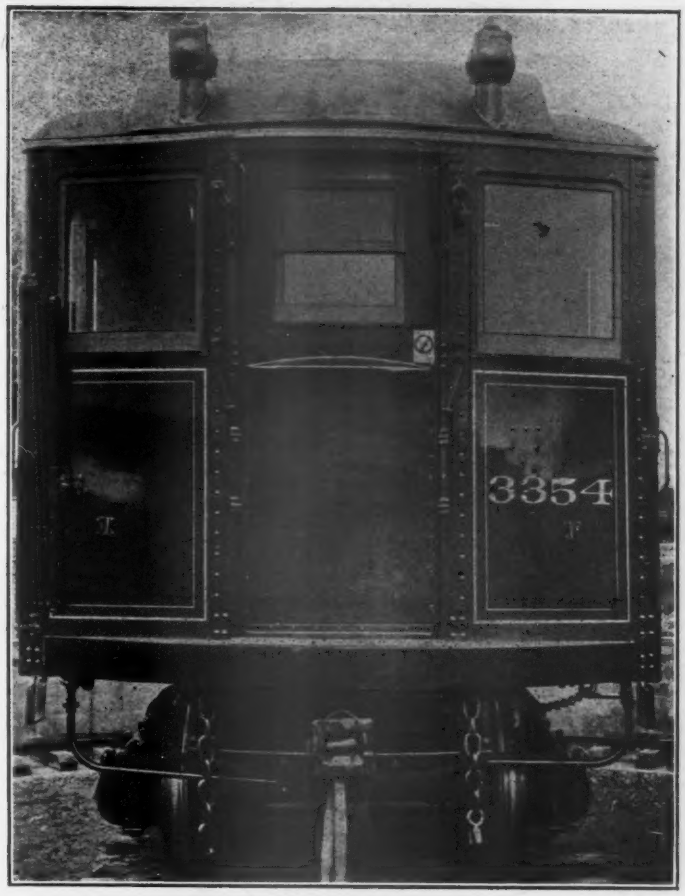


ROOF FRAMING.

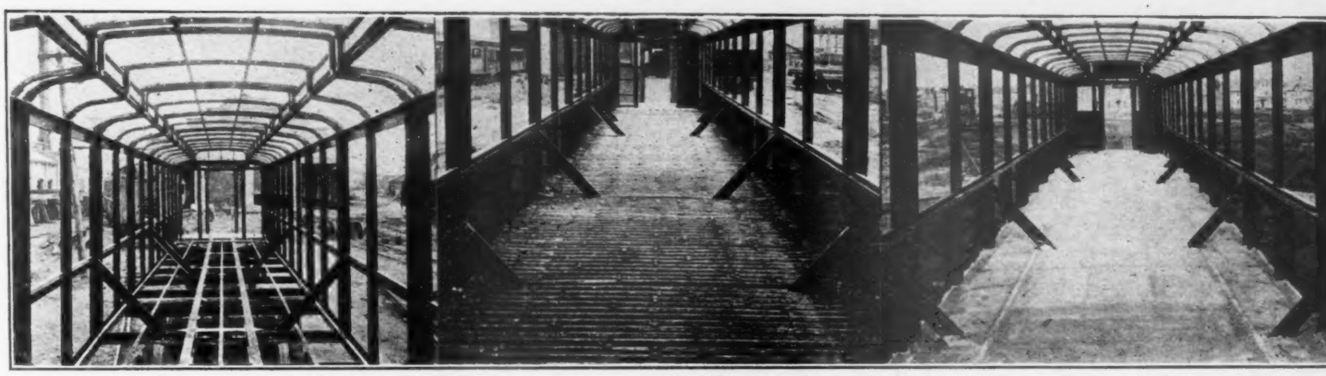
FIREPROOF CARS.—NEW YORK SUBWAY.




CROSS SECTION THROUGH FRAMING.



END VIEW.



VIEWS SHOWING THREE STAGES OF FLOOR CONSTRUCTION.

## FIREPROOF CARS—NEW YORK SUBWAY.

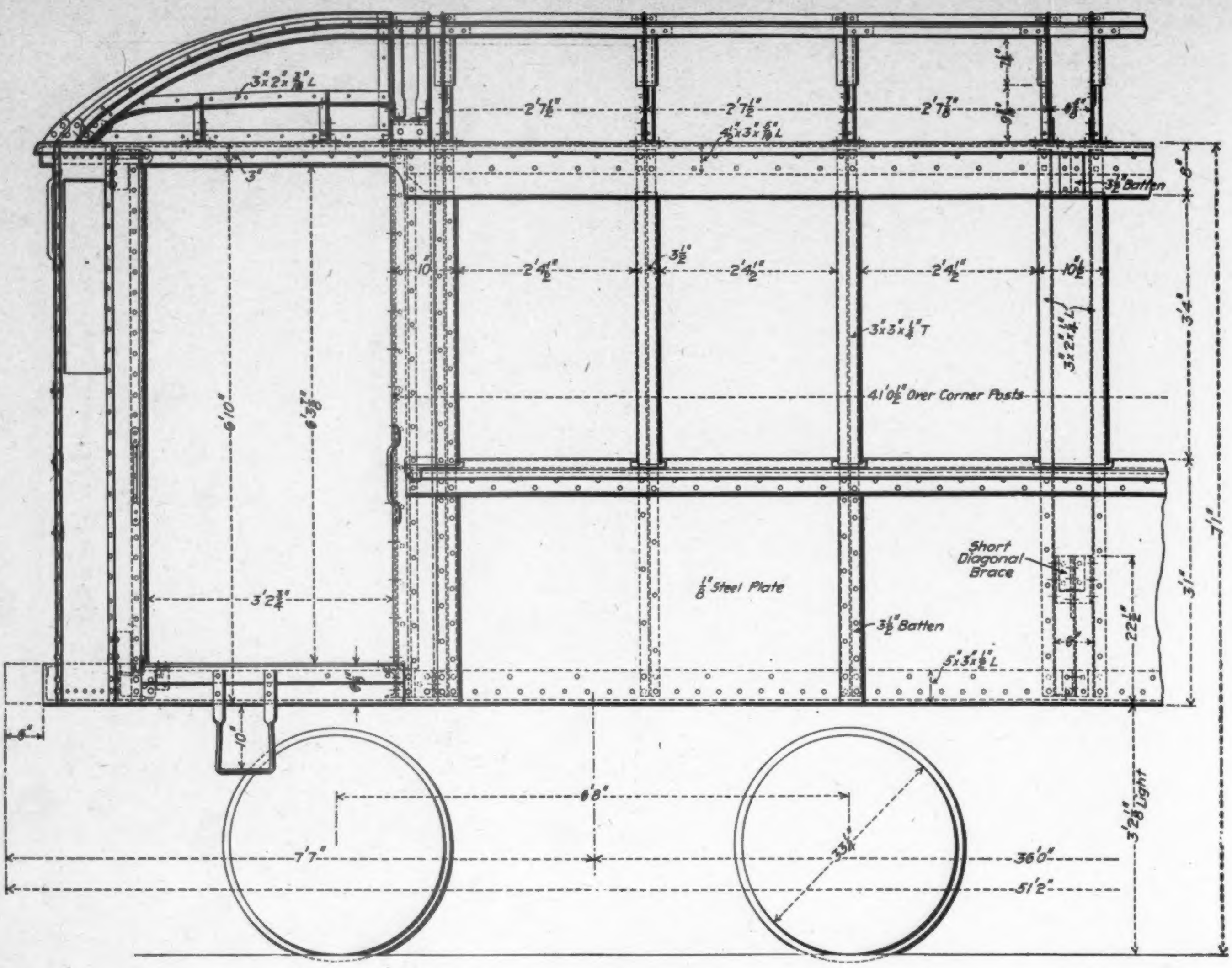
These are the first steel passenger cars ever built. There was no precedent for their construction and the boldness of the design and the responsibility assumed in constructing 300 cars from the first drawings are to be commended. An examination of the cars with a comprehension of the difficulties, including the short time allowed for the design and construction, compels admiration of the work as an engineering undertaking.

It is not difficult to build a passenger car of metal if there are no restrictions of weight and clearance. The problem worked out by Mr. George Gibbs, consulting engineer of the Interborough Rapid Transit Railway, as illustrated in these engravings, however, meets most difficult limitations of both clearance and weight.

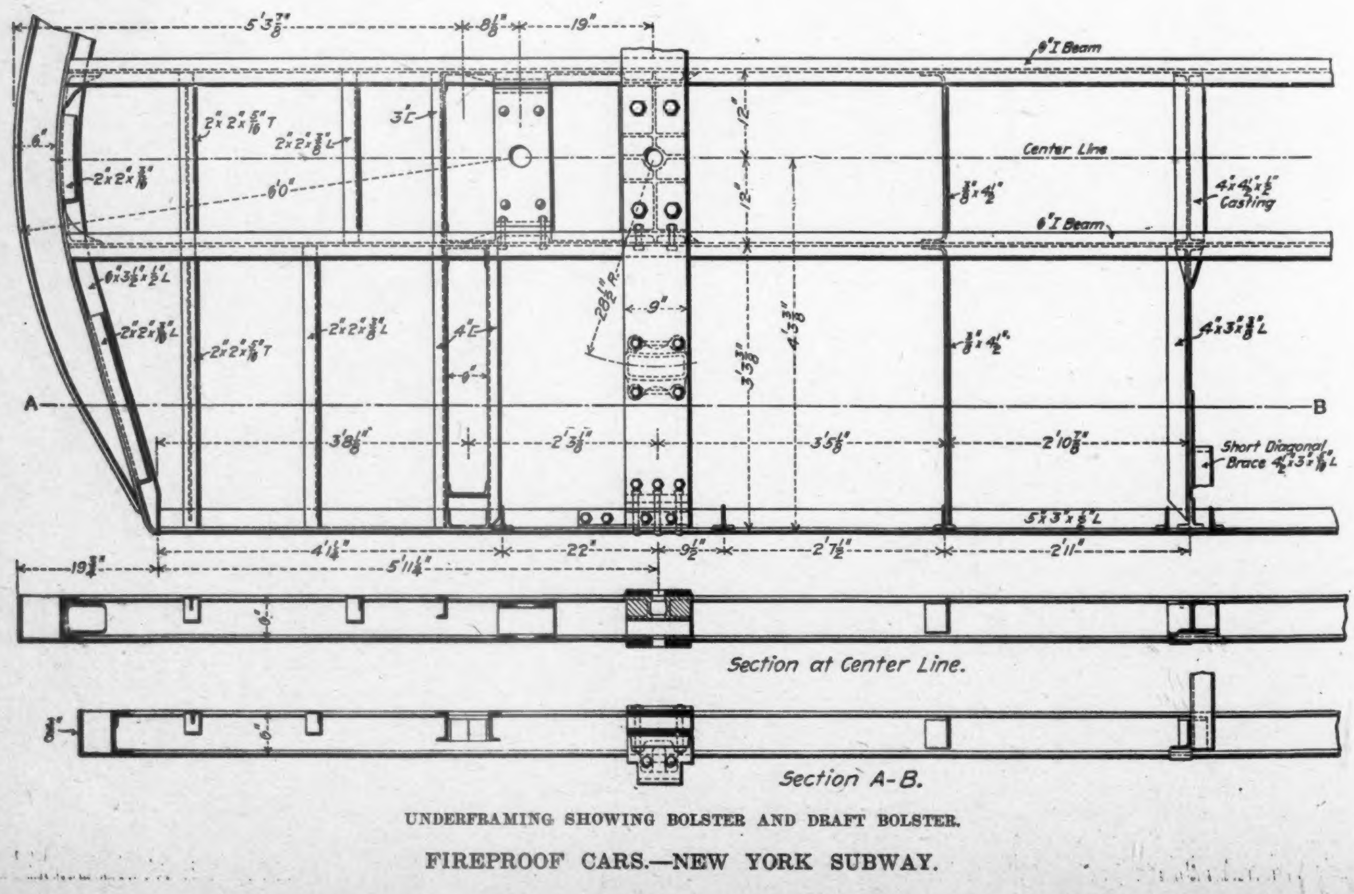
Fireproof construction, low tunnel clearances, a weight not exceeding that of present wooden cars, and stiff, strong construction, which would operate noiselessly, and be satisfactory in cold and hot weather, constituted the problem. Because of the low roof of the subway, it was absolutely necessary to use the minimum possible depth of floor. Because the car must be light the lack of floor depth could not be met by increasing the number of longitudinal sills. Therefore, side girders were used to carry the load. These girders are of ⅛-in. plate, with special bulb angles in the form of belt rails forming the upper flange, while the angle side sills form the lower flange. One of the engravings shows the framing, without the side plate girders, supported on three trucks. Without the plates in place the framing deflects considerably.

Mr. Gibbs guaranteed to produce a steel car without exceeding the weight of the wooden cars, which were illustrated in this journal in March, 1903, page 95. He has practically done so, but found it necessary to depart from the framing of the sample fireproof car illustrated in March, 1904, page 106. That car carried the load chiefly by its floor. The present design has a light superstructure resting in a structure similar to that of a gondola car, with plate side girders carrying the load. From the floor the load is carried to the side by means of cross bearers and diagonal trusses, and incidentally these braces support the side girders laterally, in which direction they are weakest. No truss rods are used, but, obviously, they may be applied if necessary or desirable. One of these cars was loaded with a full standing load and showed a deflection of 1/32-in. at the centers of the sides, showing great stiffness.

Some wood, about 680 lbs., has been used in these cars, because of a delay in securing other material. This wood is all "fireproofed," and in 100 additional cars recently ordered most of it is to be replaced by aluminum castings. It was necessary

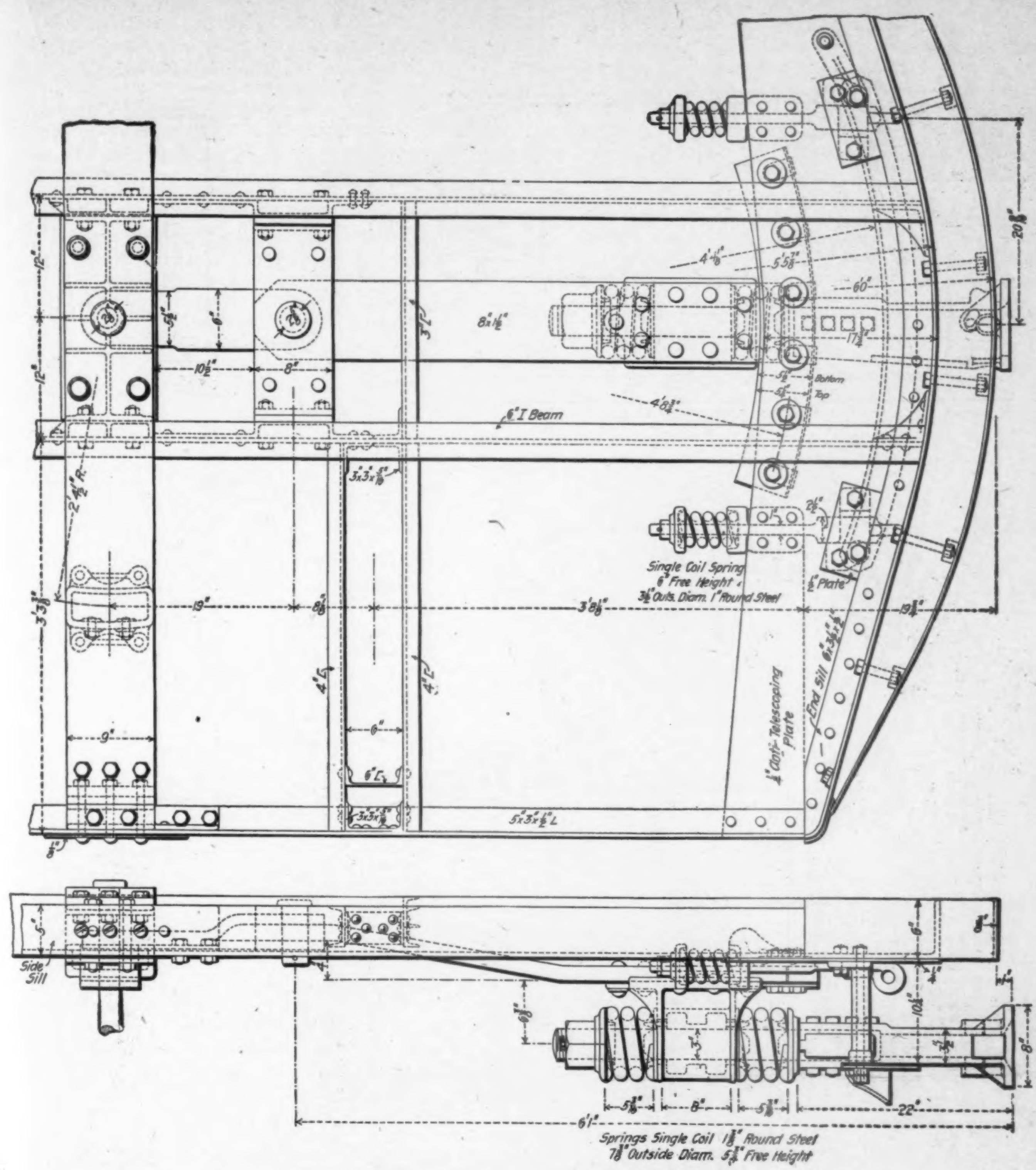



SIDE AND END CONSTRUCTION.

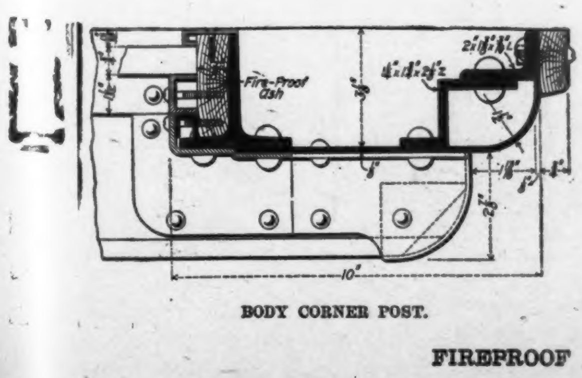



UNDERFRAMING SHOWING BOLSTER AND DRAFT BOLSTER.

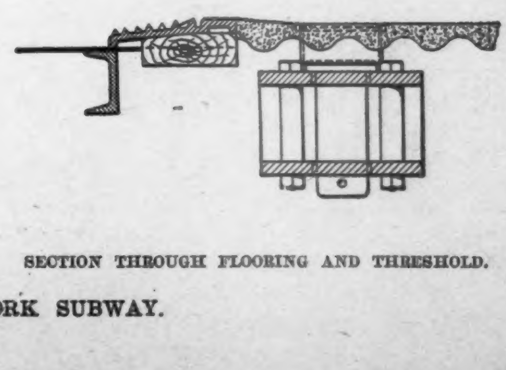
FIREPROOF CARS.—NEW YORK SUBWAY.




DRAFT RIGGING AND PLATFORM FRAMING.

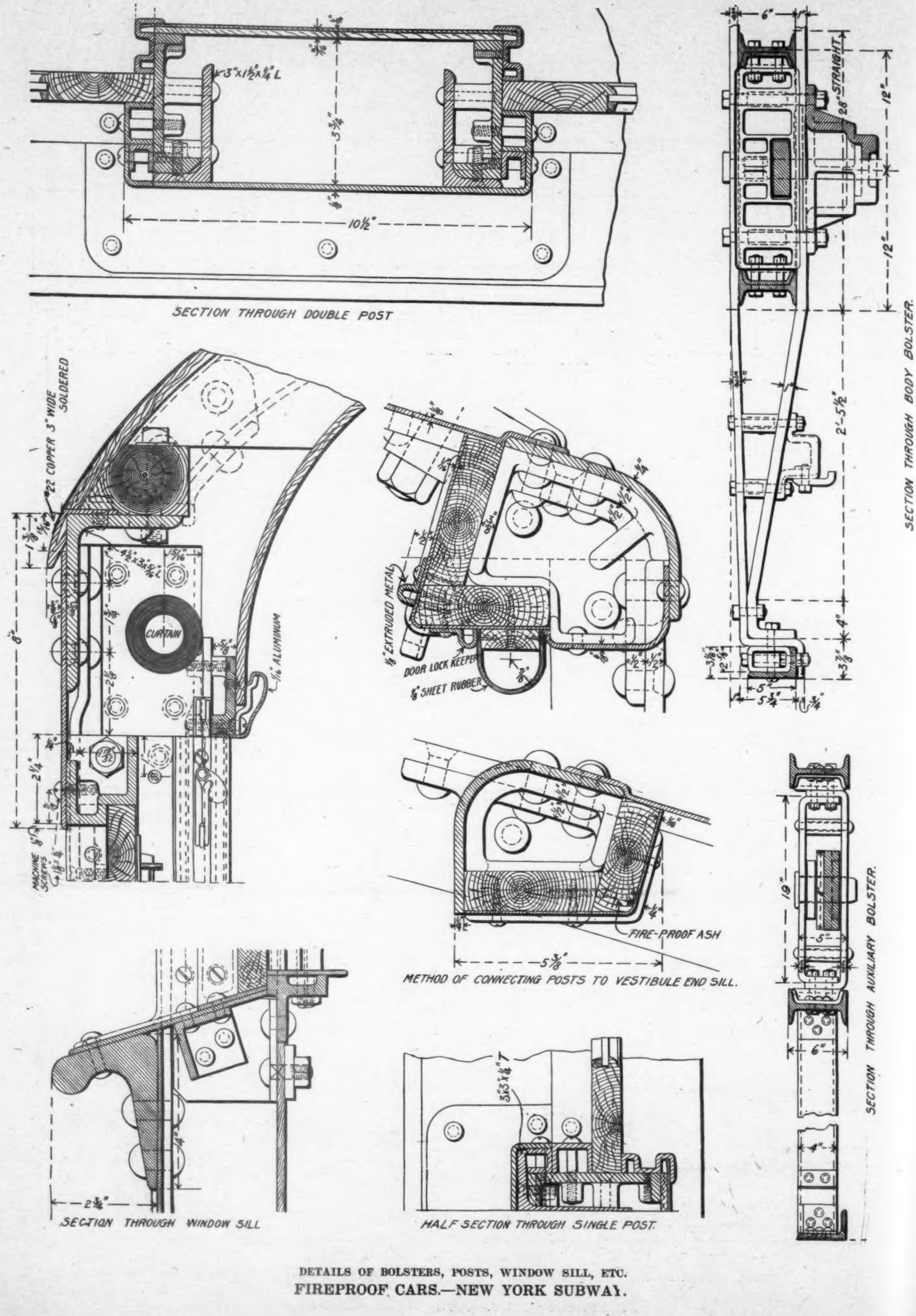



BODY CORNER POST.



SECTION THROUGH FLOORING AND THRESHOLD.

FIREPROOF CARS.—NEW YORK SUBWAY.




DETAILS OF BOLSTERS, POSTS, WINDOW SILL, ETC.
FIREPROOF CARS.—NEW YORK SUBWAY.

to use lining which would deaden sound and resist the transmission of heat, and it was desirable to use metallic interior finish for its moral effect on passengers in case of a panic in which a fire might be feared. As wide a departure as possible from the appearance of a wooden car was sought. Aluminum was decided upon because of its lightness and permanence of finish, and about 900 lbs. of this metal is used in each car. This saved about 1,800 lbs. in weight over construction requiring copper or steel.

The weight of one of the new car bodies is 34,000 lbs. The motor truck weighs 12,240 lbs., and the trailer truck 8,400 lbs. These metal cars are all equipped with motors, each car having one motor truck with two 200 h.p. motors, which are either Westinghouse No. 86 or General Electric No. 64. Local trains are to have 5 cars, 3 of which will be motor cars. Express trains will have 8 cars, 5 of which are motor cars. The equipment will consist of 300 of these new fireproof motor cars and 500 of the wooden cars as illustrated in March, 1903, the general proportion of motors to trailers being as 3 to 2. All the cars are adapted to run either on the elevated or subway lines, and are known as "interchangeable" equipment. The wooden motor cars are gradually to be changed to trailers.

GENERAL DIMENSIONS.

| | |
|---|---|
| Length over body corner posts | 41 ft. ½ in. |
| Length over buffers | 51 ft. 2 ins. |
| Length over draw bars | 51 ft. 5 ins. |
| Width over side sills | 8 ft. 6¾ ins. |
| Width over side plates | 8 ft. 7 ins. |
| Width over sheathing | 8 ft. 7 ins. |
| Width over eaves of upper deck | 5 ft. 7¼ ins. |
| Width over eaves of lower deck | 8 ft. 8 ins. |
| Width over window sills | 9 ft. ½ in. |
| Width over batteries | 8 ft. 7¼ ins. |
| Width over platform floor | 8 ft. 10 ins. |
| Height under face of sill to top of plate | 7 ft. 1 in. |
| Height under face of center sill to top of roof | 8 ft. 9⅞ ins. |
| Height of rail to top of truck center plate | 2 ft. 6 ins. |
| Height of rail to under face of side sill | 3 ft. 2⅛ ins. |
| Height of rail to top of roof (car light) | 12 ft. 0 in. |

LIST OF PRINCIPAL STEEL MEMBERS.

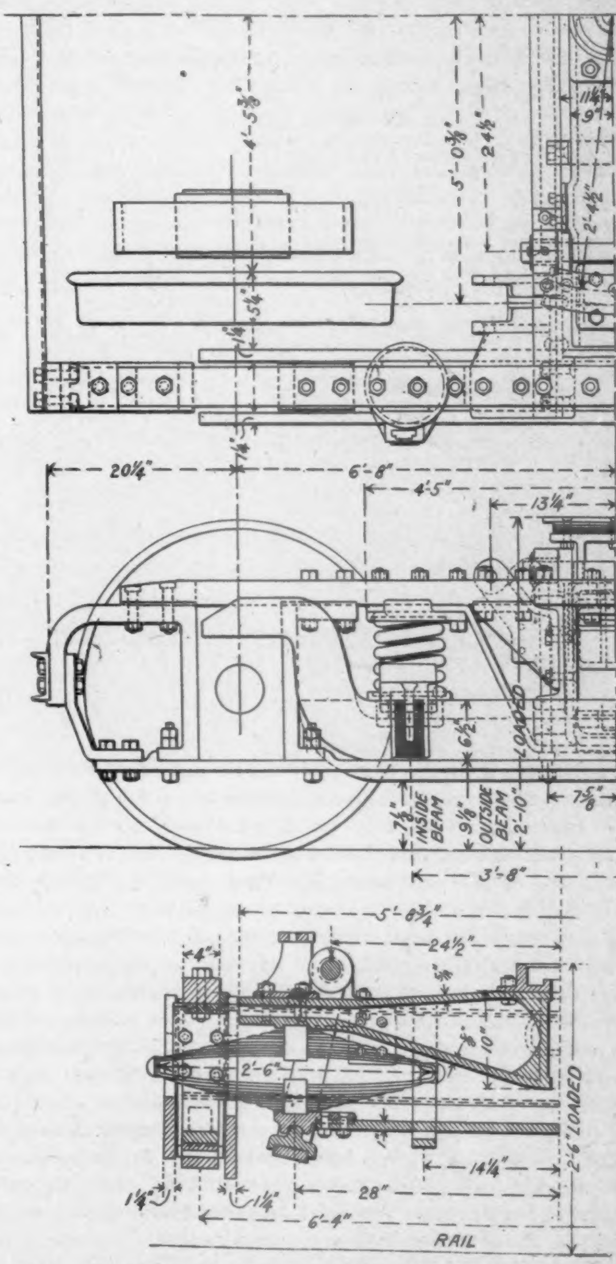
| | |
|---|---|
| Side sill angles | 5 x 3 x ½ in., 12.8 lbs. |
| Platform end sill angles | 6 x 3½ x ½ in., 15.3 lbs. |
| Side plate angles | 4½ x 3 x 5-16 in., 7.7 lbs. |
| Carline angles | 1¾ x 1¼ x 3-16 in., 1.8 lbs. |
| Purlin angles | 1⅛ x 1½ x ⅛ in., 13 lbs. |
| Cross truss, horizontal angles | 4 x 3 x ⅜ in., 8.5 lbs. |
| Cross truss, diagonal | 4½ x 3 x 5-16 in., 7.7 lbs. |
| Window sill angles | 1½ x 1½ x 3-16 in., 1.8 lbs. |
| Wainscot furring angle | 2 x 1⅜ x 3-16 in., 2.1 lbs. |
| Upper deck eaves angle | ½ x 1½ x 3-16 in., 1.8 lbs. |
| Floor support angles | 1¼ x 1½ x ⅜ in., 3.4 lbs. |
| Floor support angles | 1¼ x 1¼ x 3-16 in., 1.5 lbs. |
| Belt rails (bulb angles) | 4½ x 2¾ in., special |
| Center sill T beams | 6 ins., 17.25 lbs. |
| Body end sill channels | 4 x 1 21-32 in., 6.25 lbs. |
| Body end sill channels | 3 x 1 39-64 in., 6.0 lbs. |
| Body end post channels | 6 x 1.92 in., 8.0 lbs. |
| Single post T | 3 x 3 x ¼ in., special |
| Cross truss T | 4 x 4 in., 10.9 lbs. |
| Platform floor T | 2 x 2 x ⅜ in., 4.4 lbs. |

The side sills are steel angles, the center sills, I beams and the platform end sills, steel angles. The longitudinal sills are continuous the full length of the car, and are secured to the platform and sill by cast steel brackets and a steel anti-telescoping plate under the sills and riveted to them. The body end sills are steel channels, secured by brackets to the side and center sills. The buffer beam is white oak. The body bolsters and short draw bar bolsters are clearly shown in the detail engravings. This portion of the design has been carefully developed through experience with cars now running on the New York elevated lines.

The flooring constituted a specially difficult problem. Its construction in three stages is illustrated from photographs. It begins with galvanized corrugated sheet iron of No. 22 B. & S. gauge, laid across the longitudinal sills and secured to floor angles by rivets. Clips are provided in the corrugated plates to hold the "monolith" fireproof floor, which is finished smooth on top. "Monolith" is a composition extensively used by the Pullman Company, made in proportions of 5½ gals. "monolith," ¾ lb. raw sienna, 1/5 lb. burnt umber, 1/5 lb. Tuscan red, and 37½ lbs. "monolith" cement, all mixed with sufficient hardwood sawdust to give the material the consistency of mortar. This flooring is covered with ash strips for a wearing surface. The platform floors, of ⅛-in. steel plate, are covered with rubber matting, cemented, and also secured by large-headed bolts.

The outside roof is of "composite" board covered with canvas, and painted. It is fitted with copper flushing at the eaves. This is secured to carline fillers of fireproofed ash, which are bolted to the carlines. Composite board lining is secured to the under sides of these carline fillers, and to the composite board the final aluminum head-lining is cemented. The aluminum has a scratch brush finish, giving it a frosted appearance. The aluminum moulding for the center light wires finishes over the joints in the plates of the head lining. Composite board is a paper pulp made into a very light and strong material, which will not burn and has the properties of deadening sound and resisting heat conduction.

In the sections showing the window posts the latest development of the design is illustrated. This employs no wood except that of the window sash itself. Both single and double posts are shown. A T is used for the single post, with aluminum castings fitting the flanges, forming spacing between the sash and furnishing window stops and filling pieces. Outside, the posts finish with pressed steel in channel form, and inside the car the post finish is ⅛-in. aluminum plate over 3/16-in. composite board. A similar construction is used in the double posts, where two angles take the place of the T. In the first cars of the present order the window post construction involved fireproofed wood fillers, which have now given place to the aluminum castings. All interior mouldings and casings for the light wires are of aluminum.



MOTOR TRUCK.—NEW YORK SUBWAY CARS.

Pressed steel and angles are used for the frames of the transverse seats, and the supports of the longitudinal seats are

brackets from the sides of the car and the heater panels. The seats themselves are of rattan on frames of pressed steel. The lower window sashes are stationary and the upper sashes drop when it is necessary to open the windows. The end doors are double, and the side doors of the vestibules are of the Gibbs sliding pattern. Cabs for the motormen are formed by the end doors of the vestibules, which may be swung to enclose the controller and brake devices, placed in another position to form a compartment for the motorman, or made to close the passage between the cars. Each car has 26 10 c.p. incandescent lamps arranged in three rows with 10 lamps on each side and 6 in the center of the roof. With the reflection from the frosted surface of the aluminum headlining the lighting is exceedingly effective. Each car seats 52 persons in 36 longitudinal and 16 cross seats.

MOTOR TRUCKS.

In the following table the chief dimensions of the motor trucks are given:

MOTOR TRUCKS.

| | |
|---|---|
| Gauge of track | 4 ft. 8½ ins. |
| Distance between backs of wheel flanges | 4 ft. 5⅝ ins. |
| Height of center plate above rail with car body loaded with 15,000 lbs. | 30 ins. |
| Wheel base | 6 ft. 8 ins. |
| Weight of truck complete without motors | 12,240 lbs. |
| Weight of one motor on transom | 3,000 lbs. |
| Tongue of one motor on truck transom | 3,000 lbs. |
| Side frames, wrought iron, forged | 2½ x 4 ins. |
| End frames 5-in. channel section | 11.5 lbs. per ft. |
| Pedestals | wrought iron forged |
| Center transom 10-in. channel section | 30 lbs. per ft. |
| Truck bolster | cast steel |
| Equalizing bars, wrought iron | 1¼ x 6½ ins. |
| Center plate | cast steel |
| Spring plank, wrought iron | 1 x 3 ins. |
| Bolster springs, elliptic | 30 ins. |
| Equalizer springs, outside dimensions | 4⅞ x 7½ ins. |
| Wheels, cast steel, spoke center, steel tired | 3⅜ ins. |
| Tires, M. C. B. tread | 2⅝ x 5¼ ins. |
| Axles, journals | 5 x 9 ins. |
| Axles, diameter at center | 6½ ins. |
| Journal boxes | malleable iron |

These trucks have wrought iron side frames, machined on four sides; the end frames are steel channels, as are also the transoms, the construction being shown in the drawings. The bolsters are of cast steel, with separate center plates and side bearings, and are hung on links. Steel castings are used for the motor suspension, for brake hanger brackets, spring caps, spring seats and brake lever guides. Pennsylvania Railroad specifications are required for the axles. The trailer trucks have wrought iron frames and sandwich bolsters.

These motor trucks are very heavy and strong; they are, in fact, the heaviest and most powerful thus far used under such equipment. The engraving illustrates the construction, but does not show the motors, neither does it convey any idea of the compactness of the design as a whole. In order to facilitate the removal of wheels the outer pedestal is arranged to be easily removed. These trucks have been most carefully designed, as the very large size of the axles will indicate.

These cars are fitted with Westinghouse automatic air brakes throughout, and the motor cars are fitted with Westinghouse motor compressors and electric pump governors, in accordance with the standard of the Interborough Rapid Transit Company. The brake cylinders and auxiliary reservoirs are of the combined type, but differ from those ordinarily employed on steam railway cars in that the auxiliary is arranged so that the triple valve is mounted on the side instead of the end. The brake cylinders are also fitted with the American automatic slack adjuster of the attached type. Each motor car is provided with the Westinghouse multiple electric pump governor valve, a new device that does away with the necessity for balance wire and jumper connections through the train in order to make all the pump governors cut in at the same time for the purpose of equalizing and distributing the load on the motor compressors through the train. With this equipment but one hose connection is made between the cars, in addition to the train pipe which is always used.

## SIX-COUPLED PASSENGER LOCOMOTIVE.

BOSTON & MAINE RAILROAD.

The Boston & Maine has received new passenger locomotives of the 4—6—0 type from the Schenectady works of the American Locomotive Company, which have been giving excellent satisfaction during the rush of business to the seashore and mountains of the past summer. They have moderately wide fireboxes, and the chief interest in the design centers in the fact that this is the first example of the use of wide grates over 72-in. wheels by these builders. By bending the mud ring, a fairly deep throat sheet is obtained. These engines have piston valves with inside admission and direct valve motion. While the boiler appears to be high, its center is but 9 ft. 5 ins. above the rails, the diameter of the first ring being 66⅜ ins. In this journal for October, 1900, page 312, a wide firebox engine on the Lehigh Valley having this wheel arrangement was illustrated, the driving wheels being also 72 ins. in diameter. In this case the center of the boiler was 9 ft. 2 ins. above the rails. In the following table the most important dimensions of the Boston & Maine locomotives are presented:

GENERAL DIMENSIONS.

| | |
|---|---|
| Gauge | 4 ft. 8½ ins. |
| Fuel | bituminous coal |
| Weight in working order | 171,000 lbs. |
| Weight on drivers | 130,000 lbs. |
| Weight engine and tender in working order | 282,400 lbs. |
| Wheel base, driving | 15 ft. 10 ins. |
| Wheel base, rigid | 15 ft. 10 ins. |
| Wheel base, total | 26 ft. 10 ins. |
| Wheel base, total engine and tender | 54 ft. 6⅞ ins. |

CYLINDERS.

| | |
|---|---|
| Diameter of cylinders | 20 ins. |
| Stroke of piston | 26 ins. |
| Horizontal thickness of piston | 5½ ins. |
| Diameter of piston rod | 3½ ins. |
| Kind of piston packing | cast steel |
| Kind of piston rod packing | U. S. Metallic |

VALVES.

| | |
|---|---|
| Kind of slide valves | piston type |
| Greatest travel of slide valves | 5½ ins. |
| Outside lap of slide valves | 1 in. |
| Inside clearance of slide valves | ⅛ in. |
| Lead of valves in full gear, line and line in full gear ¼ inch lead at 6 ins. cut off For'd motion | |
| Kind of valve stem packing | U. S. Metallic |

WHEELS, ETC.

| | |
|---|---|
| Number of driving wheels | 6 |
| Diameter of driving wheels outside of tire | 72 ins. |
| Material of driving wheel, centers | cast steel |
| Thickness of tire | 3 ins. |
| Driving box material | cast steel |
| Diameter and length of driving journals | 9 ins. dia. by 12 ins. |
| Diameter and length of crank pin journals | 6 ins. dia. by 6½ ins. |
| Diameter and length of main crank pin journals, (main side, 6¾ ins. by 4¾ ins.), F & B | 4½ ins. dia. by 4 ins. |
| Engine truck, kind | swing motion |
| Engine truck; journals | 6 ins. dia. by 10 ins. |
| Diameter of engine truck wheels | 33 ins. |

BOILER.

| | |
|---|---|
| Style | extended wagon top, radial stay |
| Outside diameter of first ring | 66⅜ ins. |
| Working pressure | 200 lbs. |
| Thickness of plates in barrel and outside of firebox, | 11-16 in. 23-32 in. ¾ in., ½ in., 9-16 in. |
| Fire box, length | 102⅛ ins. |
| Fire box, width | 65¼ ins. |
| Fire box, depth | front, 72 13-32 ins., back, 51 5-32 ins. |
| Fire box plates, thickness, sides, ⅜ in., back, ⅜ in., crown ⅜ in., tube sheet ½ in. | |
| Fire box, water space | 4 ins. front, 4 ins. sides, 4 ins. back |
| Fire box, crown staying | radial |
| Fire box, stay bolts | Ulster special iron |
| Tubes, number | 336 |
| Tubes, diameter | 2 ins. |
| Tubes, length over tube sheets | 15½ ft. |
| Fire brick, supported on | water tubes |
| Heating surface, tubes | 2631.6 sq. ft. |
| Heating surface, water tubes | 27.3 sq. ft. |
| Heating surface, fire box | 159.6 sq. ft. |
| Heating surface, total | 2818.5 sq. ft. |
| Grate surface | 44 sq. ft. |
| Grate, style | rocking, in 4 sections |
| Ash pan, style | sectional, steel plate |
| Exhaust pipes | single |
| Exhaust nozzles | 4¾ ins., 4⅞ ins. and 5 ins. diameter |
| Smoke stack, inside diameter | 16 ins. |
| Smoke stack, top above rail | 14 ft. 3 11-16 ins. |

TENDER.

| | |
|---|---|
| Style | water bottom |
| Weight, empty | 48,800 lbs. |
| Wheels, number | 8 |
| Wheels, diameter | 36 ins. |
| Journals, diameter and length | 5 ins. diameter by 9 ins. |
| Wheel base | 17 ft. 4 ins. |
| Tender frame | 4-10-in. channels |
| Tender trucks | Fox pressed steel, floating bolster type |
| Water capacity | 5,000 U. S. gallons |
| Coal capacity | 10 tons |

## IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

OXFORD, ENGLAND.

To give a fair impression of the shop practice of a foreign railway from such brief visits as I was able to make is not altogether easy. I did not see all the shops, but found a contrast between the best and the worst quite as marked as we have at home.

The railroad shops of England do not present many features which we would wish to adopt. Many of them are old and are full of time-honored machinery, with some good machine tools. The shafting speed appears to be low, but those who conducted the writer about usually did not know the speeds. Concentration of an enormous amount of work in a single shop plant is the rule, and this leads to an aggregation, growing by accretion, scattered over a large area, and exceedingly difficult to supervise. No one seems to worry about shop matters, and in but a single case could the output of the shop be stated without having the figures looked up. A plant sufficient for completely maintaining 3,000 locomotives, building, say, 75 per year, and doing a vast amount of manufacturing, presents a problem which no railroad on our side of the water would dare undertake.

Altoona presents a very great contrast to most of the large plants here. As shops increase in size it becomes very difficult to provide facilities for handling material. Here the locomotive parts, except the boilers, are all light, and while cranes are sometimes provided for wheeling engines and for placing them in the erecting shops, they are not used as we use them for transporting heavy parts.

Piecework is quite common in England. Upon asking whether prices are not sometimes changed, the astonishing reply was: "Oh, yes; we change the prices whenever the men make 1½ times their day rates." This fully explained the "navy yard" pace of the shop men. The speed limit is set by the employers, and it is no wonder that repairs are extravagantly expensive, as figures, which I hope to secure permission to print, will show.

The extensive development of the use of milling machines at Crewe has been mentioned in these notes, and is worth mentioning again. So many milling cutters are used as to require a good sized tool room force to make and maintain the cutters. It has already been stated that no new planers are bought for these shops. Planers are decidedly taking a back seat in favor of milling machines. I must again mention the piles of main and side rods milled on profile milling machines by aid of formers. Main rods for Joy valve gear are made with a boss at the center, formed by means of a separate piece bolted on top of the former. Valves are finished complete by special milling cutters. These also cut the grooves at the top of the valves for the valve packing. By keeping these cutters up to standard gauges absolute interchangeability of valves is secured. Side and main rods are completely finished at Crewe by milling machines, and they are ready for the engines. Oil cups on rod ends are made rectangular in section the full width of the rods, and are finished outside by the milling cutters. Crank axles have for years been cut out of the solid by rotary planers, which are really milling machines with discs about 24 ins. in diameter having inserted teeth.

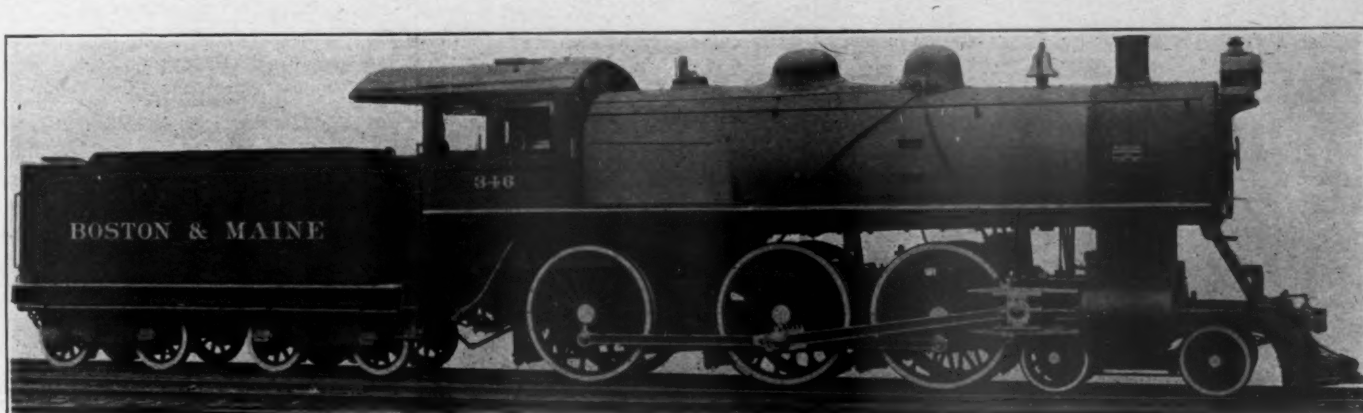
This portion of the correspondence is being written on a fast train on one of the best railroads in Scotland. The "carriage" shakes and trembles enough to entitle the writer to absolution for all the deficiencies of the letter. If those who have nothing but unqualified praise for British track would put it to the test of writing upon a pad held on the knee they would come nearer telling the truth about it. I say, and say again, that English track is not as good as our best. The cars are apt to have a quick side motion.

Attempts to ascertain cutting speeds of tire lathes and other machines were not satisfactory. One thing quite noticeable is the heavy character of the new English machinery seen in various shops. There seems to be plenty of metal about them. While some progress has been made in the application of electric power transmission, there is nothing approaching our best examples of this. At Swindon the new machine shop is electrically-driven, and the generators are driven by three Westinghouse gas engines, the gas being made at the works, and is used throughout for lighting. Gas is frequently used for furnaces. At Crewe gas producers are distributed about the works, and furnaces are fired with gas, made from bituminous coal.

Very few boring mills are used here, though their value is beginning to be appreciated, and there is no question of the superiority of our lathes to those in common use. Wheel lathes are rather light, and it is evident that they will not stand heavy feeds and fast cutting without chattering. Crank axles take up an enormous lot of room in English shops. It is by no means unusual to see a string of eight or ten big lathes working on them and occupying the full length of one side of a long machine shop.

Only in the case of the new shop at Swindon are the machines in anything like as close proximity to the erecting shop as in our recent practice. In the older shops there is almost always a brick wall between the machines and the engines, with an occasional gangway between. With longitudinal tracks in such shops, and these at close centers, it is not convenient to handle material.

Good boilermakers must be plentiful here, for the work in the boiler shops merits admiration. Careful fitting with all holes drilled is the rule. Flanging is invariably done by hydraulic presses and the boilers are designed specially for the use of dies. The relations betweeen the shops and the drafting room are direct and everywhere clearly apparent. One boiler design is made to serve several standard classes of engines. This has been carried out to an admirable extent on the Great Western. Some beautiful work in copper fireboxes with copper stay bolts was seen at Crewe. In riveting staybolts at Crewe a pneumatic hammer is used. It is held in a conical casing in such a way as to give a smooth conical head, being guided as it revolved about the rivet. With this machine all the heads are as perfectly uniform as if headed in a die. The




SIX-COUPLED PASSENGER LOCOMOTIVE.—BOSTON & MAINE RAILROAD.—4—6—0 TYPE.—WIDE FIREBOX OVER 72-IN. DRIVING WHEELS.

finished firebox was a feast for the eyes. The front ends of tubes are not beaded over as we bead them, but are left after expanding. At Crewe steel ferrules are used at the firebox ends. Leaky tubes are not a serious source of trouble here. Most of the engines are not worked hard enough to make anything leak, but the engines which are worked hard are most carefully fixed to prevent cold air from reaching the tube ends, as explained in commenting upon the new Caledonian 4—6—0 engines.

An admirable provision is made for the maintenance of rolling stock by setting aside each year a definite amount in a fund which is available for this work, and is increased from time to time with the increase in the amount and capacity of equipment. This practically provides a depreciation fund for keeping the rolling stock up to a uniform condition of efficiency.

G. M. B.

*(To be continued.)*

## NEW LOCOMOTIVE AND CAR SHOPS.

McKees Rocks, Pa.—Pittsburg & Lake Erie Railroad.

### BLACKSMITH SHOP EQUIPMENT.

The construction of the blacksmith shop building was considered in the January issue of this journal, page 24. The arrangement of the equipment, shown in Fig. 1, was very carefully worked out by the master blacksmith, Mr. A. W. McCaslin. The double forges extend along one side of the shop, with their centers about 15 ft. apart and about 15 ft. from the wall, and are placed at an angle of 45 degs. with the side wall. Double forges placed thus are economical as concerns floor space, and are adapted to all classes of work except for locomotive frames (which are handled at the large fires on the other side of the shop), and for furnace work. The foreman sitting at his desk in the office, which is liberally supplied with glass windows, can see practically everything that is being done in the shop.

of the shop is used for storing dies and material. The material racks for bar stock are painted different colors to facilitate keeping the various grades of material in their proper places. A trolley with an air hoist is provided for unloading heavy material. A No. 10 Sturtevant steel pressure blower, with a pulley on one side only driven by a 45 h.p. motor, and the water-closets are placed above the wash and locker room. The main blast pipe passes overhead from the fan and vertical pipes branch off to the forges. The large blast pipe is fitted with safety valves near each end to prevent damage in case of an explosion of gases.

The double forges (see Figs. 2 and 3) are of cast iron, are very compact, complete and durable, and while the first cost is somewhat greater than for the ordinary forge, will require no repairs and will last as long as the shop. A cellar, 12 ins. deep, extends under the entire forge, with the end inclined and projecting 2 ft. beyond the end of the forge. About two days' supply of coal is kept in the cavity under the center of the forge, while the coke is kept in the ends which are partitioned off from the center, and are divided by a removable partition at the middle into two parts, one for soft and one for hard coke. This does away with the usual coal and coke boxes, and allows free access to the forge from both the sides and the end. The outer end of the top of the forge is partitioned off to hold the good slack left when tearing down the fire. The space between the backs of the two forges is occupied by the blast valves and by shelves for holding small tools. The hood and the piece which connects it to the blast pipe are of cast iron. The forges were designed and patented by Mr. McCaslin, and are manufactured by the Monessen Foundry and Machine Company, of Monessen, Pa.

The rather high blast pressure of 14 ozs. is used, and the advantage of this can best be explained by quoting from a paper on "The Ideal Blacksmith Shop," read by Mr. McCaslin before the recent Railroad Master Blacksmiths' convention. "The writer, through experience, has determined to his own satisfaction that any volume that will fully supply each forge with

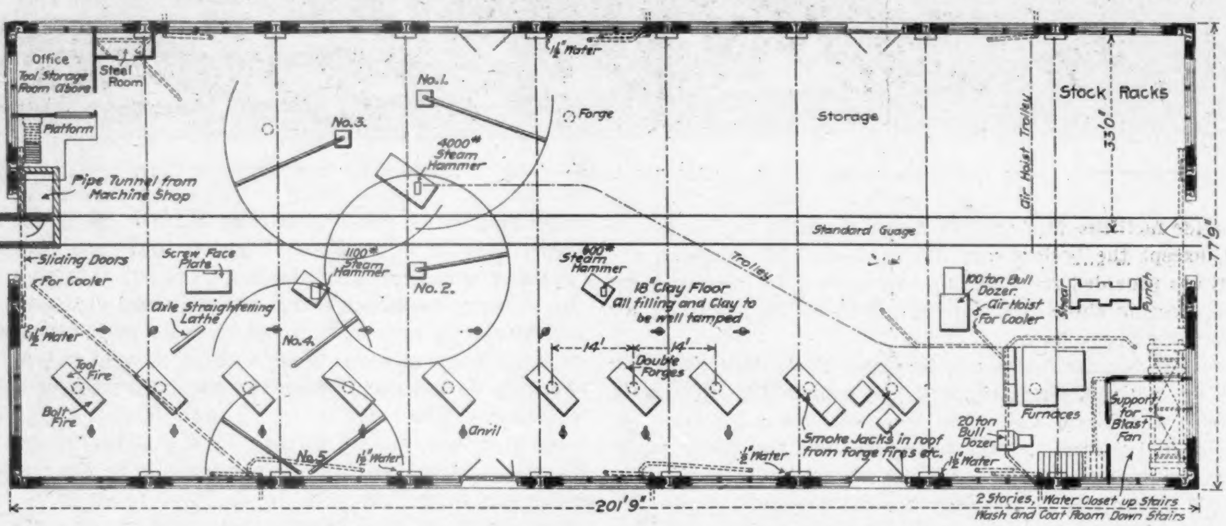



FIG. 1.—BLACKSMITH SHOP LAYOUT.—MCKEES ROCKS SHOPS.

A carefully arranged system of single jib cranes serve the steam hammers, and a double jib crane, No. 5, serves two of the forge fires used for heavy work. Three steam hammers are provided; a 4,000-lb. and a 600-lb., made by the Chambersburg Engineering Company, and a 1,100-lb., made by Bement, Miles & Co. Two large circular fires near cranes Nos. 1 and 3 are used for heating heavy work for the 4,000-lb. hammer. Two small coke furnaces are built in the double forge to the left of the small bull-dozer, and are used to heat small and short work for the bull-dozers. The pneumatic bull-dozers, a 20-ton and a 100-ton, were designed by Mr. McCaslin and built at the shops, and are used for forging anything from a bolt head or handhold to a wrecking chain hook or heavy arch bar. The furnaces between the bull-dozers are used for case-hardening and for heating heavy material, a trolley extending from this point to the large steam hammers. The large punch and shear is a Hilles & Jones No. 4, motor driven. Half of the opposite side

a constant pressure from 14 to 16 ozs. through an upright opening in the tuyere equal in area to 2 or 2½ sq. ins. is about the proper thing for railroad smith shops, not only in volume but in pressure as well. Seven ounces of blast pressure, no matter what the volume, will not heat iron as rapidly as the iron will absorb heat, consequently with that pressure we do not get a maximum output, while with 14 to 16 ozs., regulated to suit conditions and requirements, every heat unit up to the limit of absorption in the iron can be utilized, and the earnings of the employer, also the piece worker, increased, and the worry of the honest day worker through the change from unfavorable to favorable conditions greatly lessened. For ordinary work in the railway smith shop the tuyere should be at least 10 ins. below the top of the forge. With this depth and the fire prepared with fine wet slack well tamped around a stake the fire will, with possibly the throwing out now and then of a small clinker, last from 7 o'clock a. m. until

noon, and the slag and clinkers do not drop down and clog it as they will at a less depth; besides, we have a body of fuel below the iron sufficient to produce and continue to produce the necessary heat for the best results, and lessen the demand for a new fire at 9.30 a. m. and 3.30 p. m."

The anvils are placed on portable cast iron stands so that the smith can shift or turn the anvil to suit his work. Continuous wrought iron brackets or supports are placed along the side

FIG. 3.—CAST IRON DOUBLE FORGES.

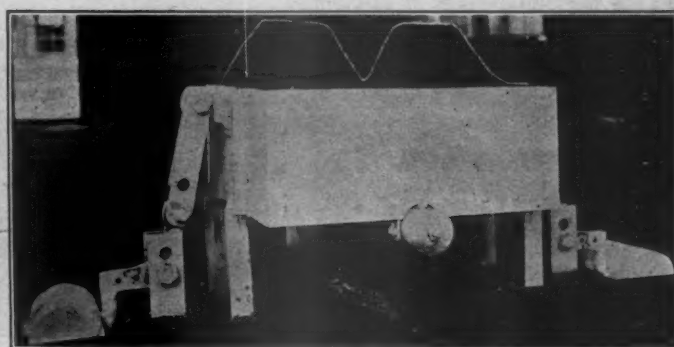


FIG. 4.—DROP FIRE FOR LOCOMOTIVE FRAMES.


FIG. 2.—BLACKSMITH SHOP.—MC KEES ROCKS SHOPS.

wall nearest the forges to hold the tools. The water tubs are made of cast iron, and are let down nearly level with the floor-line. In Fig. 4 is shown a unique forge, designed by Mr. McCaslin, for heating locomotive frames. With an ordinary forge it is necessary to either raise the heavy frame out of the fire or to swing it to one side, and thus disarrange the fire so that it is necessary to build it up again before another heat can be taken. With this special forge it is only necessary to shut off the blast, disconnect the pipe by means of a slip joint and raise the large counterweights, which causes the fire to drop 12 ins., the box being guided by the upright posts, which fit in slides on the ends of the box. This leaves the fire in good condition, ready for another heat.

One very noticeable feature of the shop is the good light and the entire absence of smoke or gas. The stacks from the forges are about 22 ins. in diameter at the hood, extend 12 or 15 ft. above the roof and create such a strong draft that the smoke is all carried off.

This shop does all the smith work for the locomotive depart-ment, which is at present repairing about 17 engines per month, and for the car department, which takes care of over 12,000 cars. While it may appear small for this amount of work, yet, due to the way the work is handled and to the labor and time-saving devices which have been introduced, the number of work-men employed has increased very little over what it was ten years ago, although the amount of work has increased several times. The shop is not equipped for making bolts on a large scale.

## EFFECTIVE USE OF "THE AMERICAN ENGINEER."

A well known superintendent of motive power sent to the editor of this journal a copy of a letter written by him to four of his subordinate officials, which reads as follows:

"I am mailing you a copy of the AMERICAN ENGINEER AND RAILROAD JOURNAL which contains some marked articles which I would like you to read. Please study particularly the article by Mr. Jacobs on page 333, on the subject of High Speed Steel in Railroad Shops. It appears to me that every one else is doing better with high-speed steel than we are, and I think there should be a general speeding up of all our tools where high-speed steel is used.

"The article on page 331, entitled Piece Work, by Mr. L. G. Parish, will also interest you. It contains important sugges-tions which you should note.

"I would also like to call your attention to the marked article on Blue Heat in Boiler Plates, on page 349. Please arrange to make a test and advise me what results you obtain by follow-ing the directions of this article.

"I would like a reply stating your opinions on these sub-jects as applied to our conditions."

The gentleman referred to has applied many improvements in his department by systematically following this plan of in-teresting his assistants in the practice of other railroads as described by the technical press, and has led them to develop many adopted as well as original ideas by this method.

## PISTON VALVES WITH RELIEF PLATES.

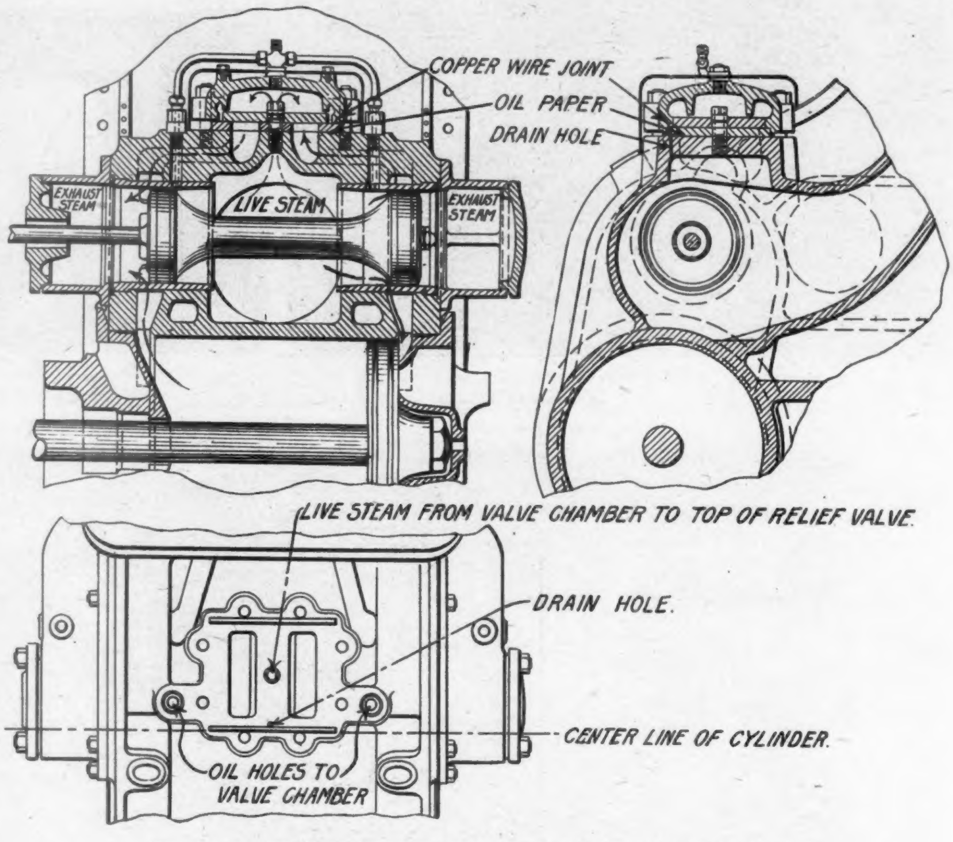
PENNSYLVANIA RAILROAD.

The most recent design of locomotives on the Pennsylvania Railroad is Class B-6, for switching service, and the first of the class was built at Altoona for the Pennsylvania Lines West of Pittsburg. It is the heaviest locomotive for this service carried on six driving wheels, and has 22x24 in. cylinders, 56-in. driving wheels, and weighs 170,000 lbs., or 28,333 lbs. per wheel. The total heating surface is 2,495 sq. ft. The boiler has 325 2-in. tubes, 13 ft. 10 in. long, and the grate area is 41 2-10 sq. ft. The boiler is 74½ in. in diameter at the largest ring. The boiler pressure is 205 lbs. and the tractive effort 36,200 lbs.

The most interesting feature of this engine is the construction of the piston valves, which, while not entirely new, are specially noteworthy because they provide for relief of water and for the compression of drifting, after the manner of the ordinary slide valve. The admission is at the center of the valve, and the eccentrics are reversed.

The construction of this valve and the steam chest is shown in the accompanying diagram, which illustrates all of the parts in position. The valve travels in short bushings, as usual. In the upper part of the steam chest cored passages lead from the steam ports upward, opening under a flat plate, which is set on the ground joint on top of the steam chest. A bonnet covers this plate and prevents leakage of steam to the outside. The steam chest pressure is brought on top of the plate through a hollow stud fastening through the center of the plate. This stud also prevents fore and aft motion of the plate. A separate drain passage at the lower level prevents the accumulation of water in the relief plate chest.

The ports under the plate are 9 x 3 ins. in size, and the lift of the plate is ⅛ in. against stops, which project downward from the bonnet. In drifting this plate is lifted and held away from the seat, owing to the reduced pressure in the space above the valve, this space being in communication with the steam admission passage leading to the cylinder.




PISTON VALVE WITH RELIEF PLATES.—PENNSYLVANIA RAILROAD.

This form of valve was used experimentally by Mr. J. B. Henney when superintendent of motive power of the New York & New England Railroad, Mr. Henney's first drawing being dated August 24, 1888. He used a 5½-in. piston valve, which was applied in a steam chest of a locomotive which formerly had slide valves. In a later experiment he employed two 6½-in. piston valves side by side, and doubtless the experiment would have been more successful had he used larger valves. Mr. Henney used the arrangement of relief plates, from which the construction here illustrated was adopted.

While a switching locomotive does not offer the best test of such a relief arrangement, in drifting, this construction has proven very satisfactory in this service, and is looked upon as a promising improvement over the separate relief valves which are usually employed in connection with piston valves.

## TRAVELING ENGINEERS' CONVENTION.

The twelfth annual meeting of the Traveling Engineers' Association was held in Chicago, September 13, with a large attendance, Vice-President J. D. Benjamin presiding. The opening address emphasized the importance of the cost of fuel and lubrication, and engine failures as present live questions. "The Future Engineer" was the subject of a paper by Mr. E. R. Webb. It brought out a general discussion on organization and discipline, leading to the conclusion that engineers and firemen should be hired by the traveling engineer, and that good men can be retained in the service by encouragement, education and improvement of the conditions under which they work. A discussion of progressive examinations of engineers and firemen developed strong support of the examination idea. Water tubes in fireboxes received interested attention. Those having bad waters spoke unfavorably, while others favored them (as supports for brick arches). The discussion led to a resolution to the effect that arch tubes offered an opportunity to improve economy when conditions permitted their use. Mr. Ira C. Hubbell read a paper entitled, "Valve Motion: Its Relation to Steam Economy." The discussion brought out reports of excellent performance of the Alfree-Hubbell valve gear. As an argument for more attention to valve gear, Mr. Hubbell pointed to the expense of $123,000,000 for coal for American railroads for the year ending June 30, 1902. The high-speed brake was discussed by aid of a paper by Mr. L. M. Carlton, which outlined the new problems of braking with increased pressure. Wheel sliding was one of these. A paper on headlights by Mr. A. L. Beardsley brought out favorable opinions of electric headlights. The discussion chiefly concerned the location and care of headlights and the location of the turbines. Among the valuable features of the convention was a paper on the "Baldwin Balanced Compound Locomotives" by Mr. M. Carroll, followed by an interesting address on the same subject by Mr. S. M. Vauclain, which was illustrated by stereopticon slides. Some of the exhibits at this convention are referred to elsewhere in this issue.

## COST OF GAS ENGINE POWER.

It is interesting to note the expense of fuel of a horse-power in a gas engine with the fuels ordinariy used:

FUEL COST PER HORSE-POWER FOR 24 HOURS WITH—

| | |
|---|---|
| Producer gas from coal at $3 per 2,000 lbs. | 3.5 to 5.5 cents |
| Producer gas from coke at $4 per 2,000 lbs. | 7.5 to 9 cents |
| Natural gas (800 B. T. U.) at 25 cents per 1,000 ft. | 9 cents |
| Illuminating gas (600 B. T. U.) at 75 cents per 1,000 ft. | 36 cents |
| Gasoline, ⅛ gallon per horse-power, at 16 cents per gallon. | 48 cents |
| Steam from coal at $3 per 2,000 lbs. | 9 cents |

(From a pamphlet issued by R. D. Wood & Co., Philadelphia, Pa.)

## PERSONALS.

Mr. James W. Hill has resigned as master mechanic of the Peoria & Pekin Union Railway, at Peoria, Ill., after 18 years' service in that position.

Mr. E. N. Gower has been appointed superintendent of motive power of the Gainesville Midland Railroad, with headquarters at Gainesville, Ga.

Mr. E. Jones has been appointed master mechanic of the St. Louis, Iron Mountain & Southern, with headquarters at Baring Cross, Ark.

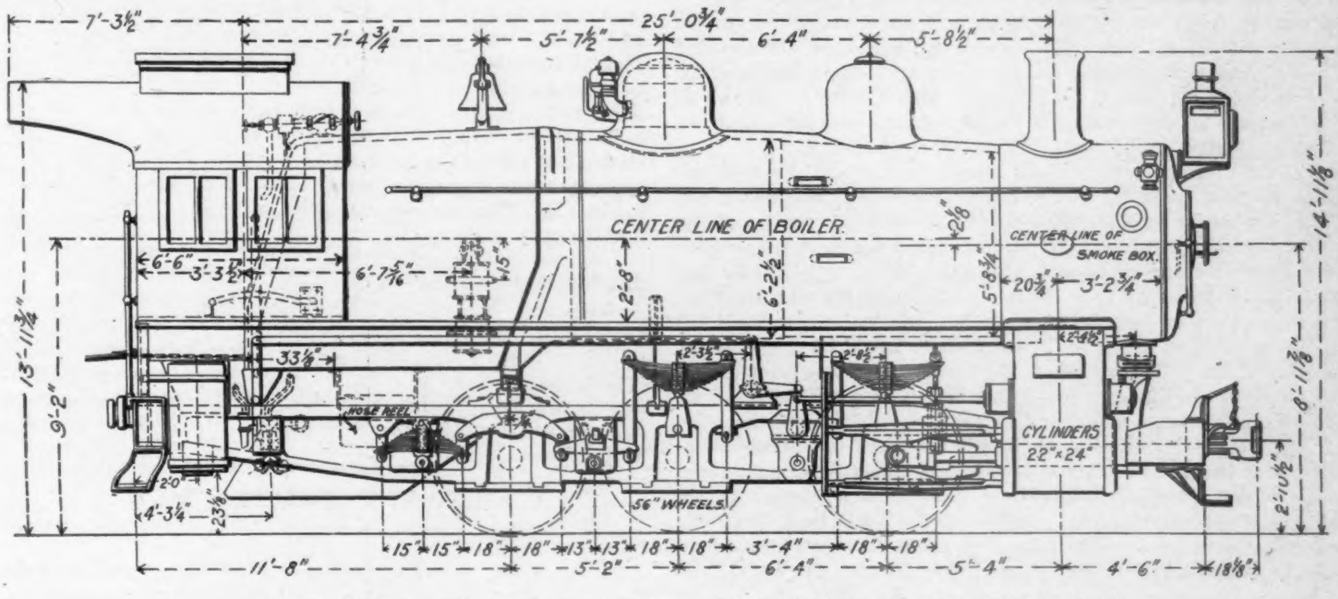
Mr. James Farrell has been appointed acting superintendent of motive power and machinery of the National Railway of Mexico, with headquarters at Laredo, Texas.

Mr. J. N. Borrowdale has been appointed general foreman of the car department of the Illinois Central at Chicago, succeeding Mr. C. D. Pettis, resigned.

Mr. C. B. Cramer, master mechanic of the Charleston shops of the Southern Railway, has been transferred to the shops at Sheffield, Ala., succeeding Mr. G. N. Howson.

Mr. H. T. Herr has resigned as master mechanic of the Norfolk & Western at Roanoke, Va., to accept an appointment as assistant to the vice-president of the Denver & Rio Grande Railroad, with headquarters in Denver, Col. Mr. Herr is assigned to special work in the operating department.

F. D. Adams, veteran master car builder of the Boston & Albany Railroad, died last month at his home in Buffalo at the age of 82 years. His life work was connected with cars, beginning in 1847, when he entered the service of the Norwich Car Company, at Norwich, Conn. In 1853 he went to Buffalo as a contractor in the Buffalo Car Works. His first railroad position was that of master car builder of the Buffalo & Erie in 1859. In 1868 he became superintendent of the Ohio Falls Car Company. In 1870 he went to the Boston & Albany as master car builder, and filled this position until his retirement from active service in 1896. Mr. Adams was a charter member of the Master Car Builders' Association, and was closely associated with it up to last year. He will be greatly missed because of his gentle strength, his faithfulness, and his thorough knowledge of his vocation and his uprightness of character. Mr. Adams performed a marked service for the railroads in the construction and successful operation of very light passenger cars for a period of over 20 years, and yet because of his quiet disposition few knew of this work. It gives an impression of the great progress in transportation to reflect on the fact that Mr. Adams saw the beginnings of railroads in his boyhood.




CLASS B-6 HEAVY SWITCHING ENGINE WITH PISTON VALVES.—PENNSYLVANIA RAILROAD.

Mr. L. P. Ligon has been appointed master mechanic of the eastern division of the Norfolk & Western Railway, with headquarters at Roanoke, Va., to succeed Mr. H. T. Herr, resigned.

Mr. R. W. Burnet has resigned as general foreman of car repairs of the Central Railroad of New Jersey to accept the position of assistant master car builder of the Erie Railroad, with headquarters at Buffalo, N. Y.

Mr. L. D. Gillett has been appointed master mechanic of the Pocahontas division of the Norfolk & Western Railway to succeed Mr. L. P. Ligon, and Mr. J. M. Thomas has been appointed general foreman at West Roanoke, Va., to succeed Mr. Gillett.

Mr. C. D. Pettis has resigned as general foreman of the car department of the Illinois Central at Chicago to accept the position of superintendent of the car department of the St. Louis & San Francisco at St. Louis, Mo.

Mr. George W. Seidel has been appointed master mechanic of the Chicago, Rock Island & Pacific Railway, at Horton, Kan. He is succeeded as master mechanic of the Southern Railway at Birmingham, Ala., by Mr. G. N. Howson, transferred from the same road at Sheffield, Ala.

## MINIMUM SUBURBAN TRAIN STOPS.

ILLINOIS CENTRAL RAILROAD.

In describing the new suburban service cars on the Illinois Central (AMERICAN ENGINEER, September, 1903, page 327) the reduction in the periods of waiting at stations for loading and unloading expected from the side door cars was prominently mentioned. Information recently received from Mr. A. W. Sullivan, assistant second vice-president of the road, indicates that the expectations of the officers have been fully realized. Not only have the cars been operated for a year without costing anything for repairs, but they have furnished absolute protection against personal injury of passengers. The station stops are marvelously short. A recent stop-watch test, made without the knowledge of the trainmen, showed an average of 7.75 seconds for the stops on a heavy run, the minimum being 3 seconds and the maximum 12 seconds.

Even if these cars were very unsatisfactory in other ways, which they are not, this feature of reducing the loss of time at stations for the movement of passengers should entitle the side door principle to the earnest attention of those dealing with crowded suburban service trains.

# CORRESPONDENCE.

## PACIFIC VS. 2-6-2 TYPE LOCOMOTIVES.

*To the Editor:*

Your statement in the description* of the latest design of 2-6-2 locomotive of the Chicago, Burlington & Quincy Railroad, in your September issue, that "There seems to be no question of the advantages of the type (the 2-6-2) over the Pacific type with a 4-wheel leading truck," appears to the writer to be, both on principle and in view of results in practice, so manifestly correct and well founded that the grounds for the recent comparatively extended adoption of the Pacific type by railroad managers are not easy to see. It is, of course, to be assumed that those who have added locomotives of this type to their equipment have done so for reasons which they found or considered to be good and sufficient ones, and this communication is presented more particularly in the hope of developing an expression of the views of those who advocate the Pacific type, than with a desire to urge the superiority of the 2-6-2.

Whether or not trailing wheels are, in and of themselves, desirable in a road locomotive, need not be here considered, inasmuch as in designs embodying driving wheels of large diameter and a wide firebox, which the logic of facts has demonstrated to be *essentials* in heavy and fast passenger train service, they are absolutely indispensable. Moreover, as they are used, and similarly used, in both the 4-6-2 and the 2-6-2 types, the two are, in this respect, identical, and the question of relative advantage between them depends wholly upon the conditions and requirements obtaining and existing forward of the front driving axle, which are comparatively few and simple. In order to support the weight which overhangs the front driving axle upon a 4-wheel truck, as in the 4-6-2 engine, there must—not necessarily, but upon the accepted lines of American practice—be an increase of wheel base and an increase of boiler length, as compared with the 2-6-2 engine. Is this increase accompanied by a corresponding advantage; if so, in what particulars, and if not, why should it be made?

The 2-6-2 engines of the Lake Shore, class J, and the 4-6-2 engines recently built by the Baldwin Locomotive Works for the Chicago & Alton, may be referred to as fairly representative of the two types under consideration. Assuming the distances from centre of exhaust to centre of front driving axle (67 ins. in the 2-6-2 and 95½ ins. in the 4-6-2) to be the minimum admissible with an 80-in. wheel, we have an increase of wheel base of 28½ ins. in the 4-6-2 engine, and, other things being equal, there would be the same increase of boiler length. While the longer wheel base is of course not, of itself, desirable, it may, for present purposes, be taken as not positively objectionable, and neglected as a factor in the comparison. If the increased boiler length is utilized to provide a corresponding increase of tube heating surface, steam room and weight available by adhesion, it would, in these regards, constitute an element of advantage of the 4-6-2 over the 2-6-2 type, but such possible advantage cannot, in the first place, be made fully available, by reason of what are, or are believed to be, the limitations of practicable tube length, and for this, or for some other reason not apparent, it has not been fully availed of in the Chicago & Alton and other engines of the 4-6-2 type.

The distance from centre of exhaust to front tube sheet is, in the Lake Shore 2-6-2 engine, 36 ins., and might be shorter if desired, being 29 and 30 ins., respectively, in other large engines of the same type. The tubes are 19 ft. long. In the Chicago & Alton engines this distance is 55 ins., and the tubes are 20 ft. long. It will therefore be seen that 19 of the 28½ ins. of extra boiler length are not utilized for steam generating purposes, and act, without apparent advantage and possibly with disadvantage, to increase the volume of an already large smokebox. Briefly stated, the 28½ ins. of increased wheel base of the 4-6-2 engine attains no positive advantage, and two-thirds of the increased boiler length is either useless or unutilized.

If such increase of steaming capacity as is resultant upon the use of 20-ft. tubes is deemed desirable, it can be provided in a 2-6-2 as readily as in a 4-6-2 locomotive and without involving undesirable increase of wheel base, useless expansion of smokebox volume, or variation from standard or existing draught appliances. It is therefore the opinion of the writer not only that all the advantages of the 4-6-2 type are fully attainable in the 2-6-2, but also that the latter, as to the features of shorter wheel base and simpler and less expensive construction, possesses positive advantages over the former.

There remains, or it may perhaps be contended, there should be first considered, the question of the relative merit of a 2 and a 4-wheeled truck, and this is one which cannot be fully discussed within the permissible limits of this communication. As stated in your article on the Chicago, Burlington & Quincy locomotives, "This road has a long and very satisfactory experience with 2-wheel leading trucks," and this statement may be made with equal correctness as to various other roads, particularly the Lake Shore and Philadelphia & Reading. The 2-4-2 engines of the latter road have been operating trains between Philadelphia and Jersey City at exceptionally high speeds for a number of years, and have done so as safely and as satisfactorily as engines having 4-wheel trucks in the same service. In view of the present extended use, at high speeds, of 2-wheel leading trucks, railroad managers cannot reasonably question their safety in, or adaptibility to, service of this character, and their effectiveness at slower speeds has long since been fully demonstrated and universally accepted. Under these circumstances the substitution of the 4-wheel truck, as in the Pacific type, must be warranted, if at all, by its own superior advantages and not by supposed disadvantages of the 2-wheel truck. Neither of these, as it seems to the writer, has been shown to exist.

J. SNOWDEN BELL.

Pittsburgh, Pa., September 6, 1904.

## A TECHNICAL SCHOOL GRADUATE OF SEVEN YEARS' EXPERIENCE.

*To the Editor:*

The communications on the subject of apprenticeship which have appeared in your paper will not be complete without a brief statement of my experience. I was graduated from the Massachusetts Institute of Technology seven years ago. After serving three years as a special apprentice and fulfilling the requirements of the officials as an apprentice, I was given special work of various interesting kinds and made myself generally useful to those officials. After seven years I have become foreman, with less salary than a draftsman of ordinary ability can secure any day. In fact, I am paid $95 per month. It was perhaps a mistake to let this go so long, for I have been discouraged and have made up my mind to do something else. It would not matter that the salary is low if I were given an opportunity to introduce improvements, but this I am unable to accomplish. What would you advise me to do?

D. E. F.

EDITOR'S NOTE.—Get another position, but first make an impression on your superiors which will enable your successor to accomplish something. A technical school graduate having had seven years' experience is worth more than $95 per month, or he is not worth anything. This seems to be a case of the wrong railroad. Life is too short to wait for advancement under such conditions. Our correspondent has little to lose. He should try an aggressive policy to see what that would bring him. He might do worse than be dismissed.

## HELP THE MACHINE TOOLS.

*To the Editor:*

Several times, in recent issues of your paper, statements have been made implying the necessity of using specially designed heavy machine tools in connection with the high-speed tool steels, and in a number of instances you have called attention to particularly heavy cuts that have been taken on certain machines.

It seems to me that, in a railway shop, it is a sign of poor shop practice to have to take such heavy roughing cuts except on certain classes of work, such as turning worn wheel tires, rough turning axles and machining some of the heavier castings and forgings. There is no good reason why the greater percentage of locomotive and car castings and forgings cannot be made very nearly to size so that only a light roughing cut need be taken. The strains on the machine tools and the waste of material will thus be reduced and the cutting speed can be increased.

The use of high-speed tool steels, improved machine tools and better methods of handling the work will undoubtedly greatly increase the shop output and decrease the cost of production, as is very clearly shown in Mr. Jacobs' valuable article on "High-speed Steel in Railroad Shops" in your September issue. In addition, a considerable saving might also be made, in some shops at least, by carefully designing the castings and forgings with a view to reducing the amount of metal to be removed. On some of the larger forgings it may be found cheaper to machine the metal off than to forge it near the finished size, and occasionally it may be found advisable to leave a surplus of metal on irregular castings in order to facilitate molding, or to relieve shrinkage strains, but such cases are not frequent.

Apparently, one road at least has taken some steps along this line, for in the description of the McKees Rocks shops in your Sep-

tember issue it is stated that "most of the forgings and castings are so made that they can be finished by taking a comparatively small roughing cut, and the old machine tools, even though cutting at a considerably higher speed than before, can easily handle this class of work." Reference to the list of the motor-driven machine tools in the machine shop at McKees Rocks will show that more than 60 per cent. of them are old tools, which were designed before the high-speed tool steels came into use, and in view of this fact it is interesting to note that, "although new tool steels and commercial methods are being introduced into this shop as rapidly as possible, yet the old machines are giving good satisfaction in practically all cases."

I do not wish to advocate the use of old and worn out machine tools in our railway shops, for the question of shop output and the cost of production is one of vital importance to the railroads, and they should pay as much attention to it as a large commercial establishment does. At the same time it would appear that with a little care in the designing of castings and forgings old machine tools in good condition could in many cases be fitted up at a small expense so that they could be used to good advantage in a modern railroad machine shop.

M. M.

## SPECIAL APPRENTICESHIP.

*To the Editor:*

For some time my interest has been centered on articles appearing in your journal relative to special apprentices, not merely from a personal point of view, but from a knowledge of many young men who have taken up the work and are drifting, as it were. On reading the letter signed "A. B. C." in your September number the expressions of that writer were so nearly the conclusions that I have found from my experience and observation that I want to say "amen" to the conclusions that he has drawn.

Upon completion of my special apprenticeship course I felt capable of earning at least what an ordinary mechanic was paid and expressed a desire to know whether I would receive that rate or not. To make the story short, would say that those in charge, after keeping the question hanging for several weeks, notified me that I would be paid 5 cents less per hour than the rate paid machinists on that system. It was merely a question of leaving the road, for me, but the action taken by the officials does not look business-like or logical. Furthermore, to be advised by the superintendent of motive power to join the machinists' union and then be denied the scale paid members was to me a polite way of saying, "Get out!" I might add that a statement was given me saying that my services had been entirely satisfactory.

To clinch matters, I have been doing machinist's work the past two months at the ——— shops, not merely to prove to myself that I can handle the work satisfactorily, but to gain experience and incidentally earn more than had I remained with the ——— Railroad. Your journal is bound to do a good missionary work and by continual drubbing may turn the tide.

G. H. I.

EDITOR'S NOTE.—This young man is bright, thoroughly capable and a graduate from the electrical engineering department of one of our large universities. He is bound to win out in the end and we trust that he will not give up the fight as hopeless. Is it any wonder that the railroads are losing some of their brightest young men?

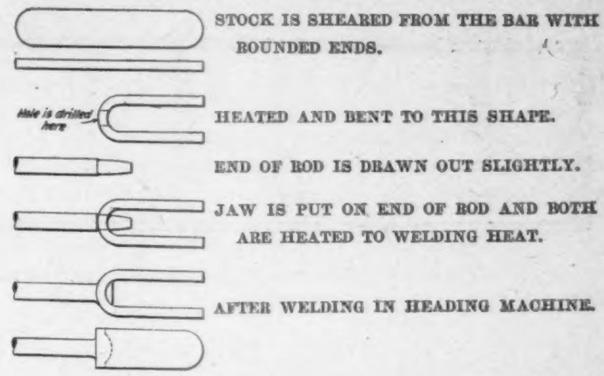
## METHOD OF MANUFACTURING BRAKE-RODS AND PUSH-BARS.

*To the Editor:*

The method of manufacturing brake-rods and push-bars followed by the car department of the Cambria Steel Company is quite different from that of the majority of shops. In the Cambria shop the jaw or end of the brake-rod is made from bar iron which is sheared to the right length, heated and bent into a U-shape. A hole is drilled in this U-shaped piece, at the centre of the bend, about 1-16-in. smaller than the diameter of the brake-rod.

The end of the brake-rod is drawn out slightly, leaving a square shoulder about 1½ ins. from the end. This reduced end of the rod is pushed into the hold drilled in the U-shaped end or jaw, and the two parts are heated to a welding heat. They are then placed in a heading machine, which has some special dies arranged to hold the rod and keep the jaw in the proper position while another part of the die presses against the end of the rod, upsetting the same and welding it to the jaw. The end of the rod projects through far enough so that the excess stock forms a head on the inside of the jaw, which prevents the rod from pulling out of the jaw if the weld is not perfect.

When the jaws have been welded on, the rod is completed by drilling the holes for the brake-lever pins. The writer has no figures concerning the cost of this method of making brake-rods as compared with other methods, but it produces a very good looking brake-rod, with the possible exception that the




jaws are heavy when compared with the rod. This last objection does not hold for the push-bars, and it could probably be removed in the rods by using lighter stock for the jaws. It is said that when rods made in this manner are placed in a testing machine the rods generally break without developing any weakness in the ends where they are welded to the jaws.

O. N. FERRY.

## POOLING LOCOMOTIVES—RESULTS OF A CAREFUL STUDY.

Important observations concerning pooling of locomotives are given in a report prepared by Mr. Camille Boell, superintendent of motive power of the French State Railways, to be presented before the International Railway Congress next May. The investigations by the author resulted in the following conclusions:

1. That the pooling system leads to a very perceptible increase in the expense per mile, and, therefore, it ought not to be employed except in case of absolute necessity.

2. That for the purpose of increasing the product of engines it is preferable to have recourse to the system of interposing auxiliary crews, or to the multiple crew system, the evils of which are infinitely less.

3. That the double crew system is particularly to be approved, notably for switching, suburban or shuttle train service, and even for certain classes of through train service for the reason that while affording better utilization of engines than the single crew system it may permit the realization of a slight saving of fuel without appreciable increase in cost of repairs.

4. That with these various systems there may be an advantage from the standpoint of fuel expense to assign to each engineman a particular tender, which, however, gives rise to certain complications in the service, and is not always capable of realization.

5. That the system of three-men crews may, in certain cases be substituted advantageously for that of double crewing.

It may be added, in conclusion, that other systems than that of the single crew have little to commend them for fast express train service, which demands engines in a perfect condition of repair and well understood by the enginemen who handle them.

Under usual conditions the economizer will save 12 to 15 per cent. of the coal bill each year without reducing the temperature of the gases sufficiently to seriously affect the draft. The amount saved would be, under ordinary conditions, about enough to pay for the cost of the economizer in three years. When we consider the fact that the economizer is very durable and costs but little for repairs, it will be seen that as an investment it promises to return an exceedingly large interest. —*Prof. R. C. Carpenter in Power and Transmission.*

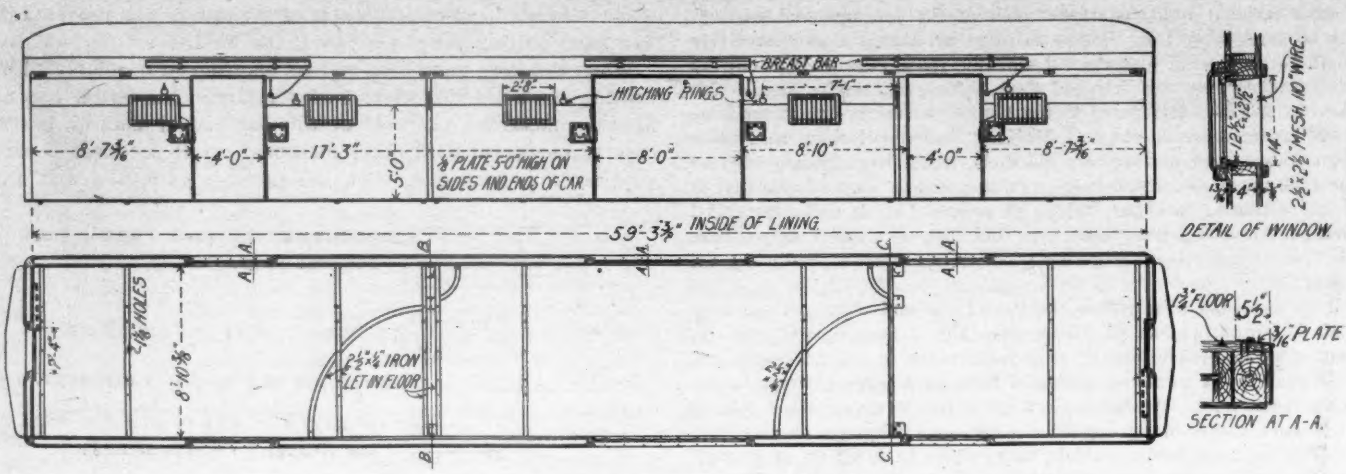



FIG. 1.—60-FOOT HORSE CAR.—CENTRAL RAILROAD OF NEW JERSEY.

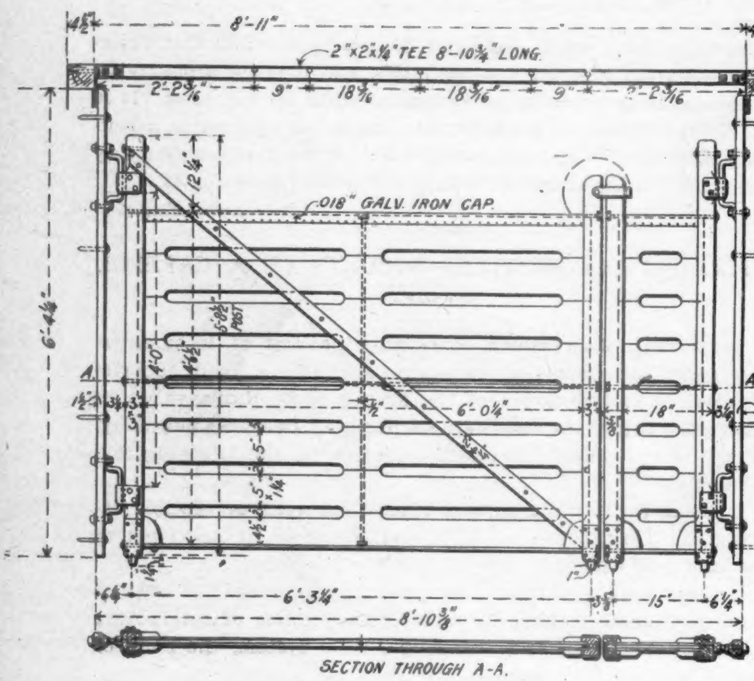



FIG. 2.—CROSS PARTITIONS.

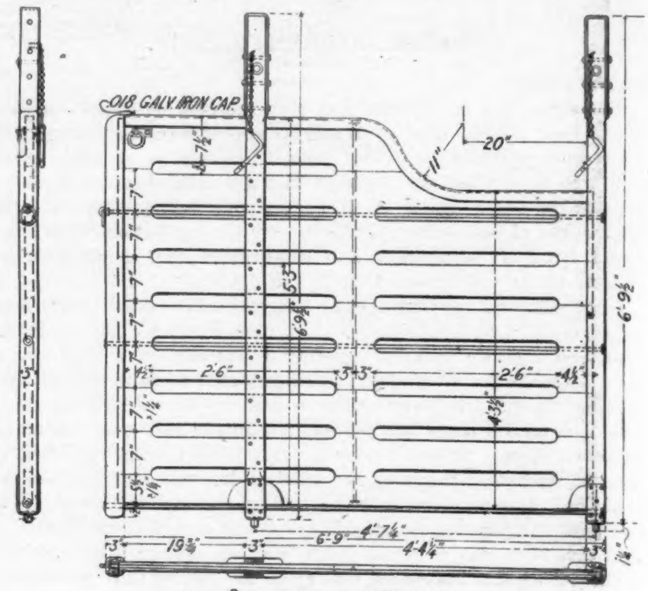



FIG. 3.—STALL PARTITIONS.

## 60-FOOT HORSE CAR.

CENTRAL RAILROAD OF NEW JERSEY.

This car was especially designed for carrying horses, but is so arranged that the stall and cross partitions can readily be swung to one side and it can be used for express or baggage. The framing is practically the same as used on the 60 ft. baggage cars on this road, except that it is modified to allow the use of one 8-ft. and two 4-ft. doors on each side, the larger doors being used for carriages. The car has stub ends and sliding end doors.

Cross partitions made in two parts, shown in detail in Fig. 2, are placed at B-B and C-C. The smaller part forms a door for the attendant as he passes from one end of the car to the other and the larger part is so arranged that it can be swung to the side of the car when not needed. These partitions are held in place by 1-in. pins at the bottom, which fit into holes in small iron plates let into the floor. Iron strips, 2½ x ¼-in., are let into the floor so that when the partitions are being swung to the side the pins will not injure the floor. The stall partitions, shown in Fig. 3, are placed lengthwise in the car and are held in position by 1-in. pins at the bottom which fit into holes in the iron strips that extend across the car and by pins which fasten the straps at the top to the T irons upon which they slide. These partitions are placed at each end of the car, at both sides of the cross partition at B-B and at the left side of the cross partition at C-C. Five sets of stalls are thus provided for and as the car is arranged for either three or four stalls crosswise it will accommodate from sixteen to

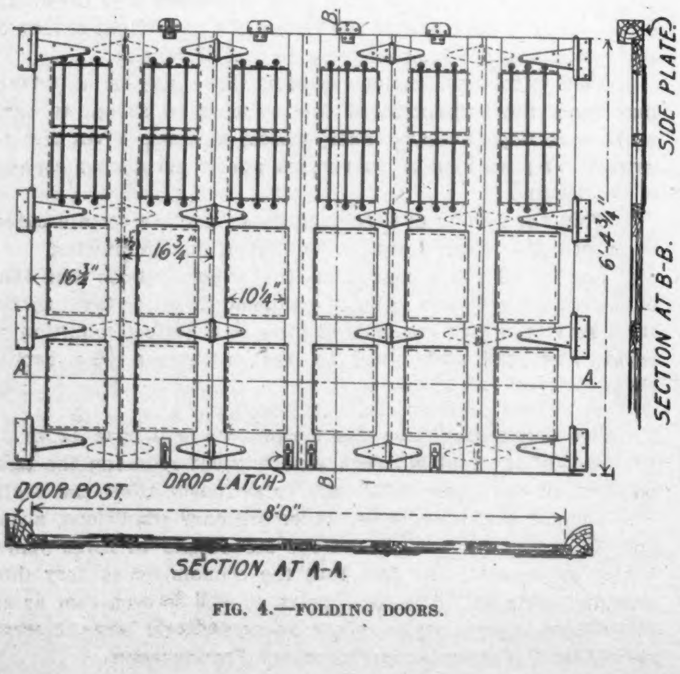



FIG. 4.—FOLDING DOORS.

twenty horses. The breast boards are supported by pocket castings on the sides of the car and when not in use are placed on wrought iron brackets above the side doors. The partitions and breast boards are made of hard wood and all corners and edges are rounded. The sides and ends of the car on the inside are covered with ⅛-in. steel plates to a height of 5 ft. from the floor.

In order to comfortably accommodate four horses across the car it was found necessary to do away with the standard sliding doors and to use folding doors, shown in detail in Fig. 4. These doors are so constructed that the joints fit tightly when closed and they are locked by ordinary latch bolts at the bottom and by special latches at the top which drop into place when the doors are closed and rest against the small iron plates on the door. The 4-ft. doors are made in the same way but contain only half as many parts. Five small sliding windows are placed on each side of the car to furnish good ventilation and light.

The car is equipped with the American Steel Foundries' cast steel double body bolsters, Standard Coupler Company's steel platrorm, Buhuop 3-stem coupler, and Westinghouse high speed air brakes. We are indebted to Mr. W. McIntosh, superintendent of motive power, and Mr. B. P. Flory, mechanical engineer, for this information and drawings.

## HEAVY FREIGHT TRAINS.

One of the 2—8—0 type freight locomotives on the Lake Shore & Michigan Southern Railway (illustrated in the AMERICAN ENGINEER January, 1904, page 12) on August 19 hauled a train of 95 steel cars loaded with coal from Ashtabula to Youngstown. The train weighed 5,974 tons. This was during a series of tonnage tests and not a part of reguıar service. August 22, coming north, the same engine, No. 1006, hauled a train of 100 steel coal cars, making a total weight of 6,762 tons, 600 lbs., exclusive of locomotive, tender and caboose. The actual running time for the 54 miles from Youngstown to Ashtabula was 4 h. 32 m. The heaviest grades are 0.2 per cent., southbound, from Ashtabuıa to Youngstown. From Mr. H. F. Ball, superintendent of motive power, the following table of test runs has been received:

TONNAGE HAULED BY ENGINE NO. 1006, AUGUST 16 TO 22, 1904.

| Date. | Cars. | Tons. | Left. | Arrived. |
|---|---|---|---|---|
| 16 | 70 | 5,584 | A* 11.15 a. m. | Y† 5.35 p. m. |
| 17 | 54 | 4,320 | A 11.30 p. m. | Y 5.15 a. m. |
| 18 | 80 | 5,164 | Y 8.50 a. m. | A 2.15 p. m. |
| 18 | 60 | 3,594 | A 11.15 p. m. | Y 6.25 a. m. |
| 19 | 95 | 5,974 | Y 12.08 p. m. | A 5.30 p. m. |
| 21 | 75 | 4,620 | A 4.48 p. m. | Y 10.45 p. m. |
| 22 | 100 | 6,762 | Y 10.58 p. m. | A 6.15 p. m. |

*Youngstown.
†Ashtabula.

These approach the length of the mythical train having but one end, and the record is a remarkable one, even though the heaviest train was hauled over favoring grades. They surpass in several instances the record train of 5,212 tons hauled 132 miles over the Pennsylvania from Altoona to Harrisburg, August 9, 1898, which consisted of 130 cars of coal. A train of 5,936 tons was hauled over the Union Pacific from Cheyenne to Sidney in 1900, but this is a favorable grade of about 32 ft. per mile, if the writer's memory serves him correctly.

The heaviest train of which we have record was that of 134 steel cars, loaded with coal, hauled from Archer to Egbert, 24 miles, on the Union Pacific, April 4, 1900. The total weight, exclusive of locomotive, tender and caboose, was 7,765 tons. The grades favored the train, and the 24 miles were made in 45 minutes.

From information supplied by Mr. D. T. Murray, division superintendent of the Lake Shore, the test trains were helped out of the yard at Youngstown by a pushing engine, but the road engine hauled the trains unaided a distance of 33 miles. Our description of the locomotive, already mentioned, and the figures given in the table on page 275 of the July number for the Class C engines for the Lake Shore, may be consulted for weights and dimensions of this locomotive. Such trains, of course, are not to be operated in regular service. The runs were made for purposes of demonstration of the capacity of the locomotives.

## COAL CONSUMPTION OF LOCOMOTIVES.

One of the reports at the convention of the Master Mechanics' Association last June, received too late for appropriate discussion, was that on locomotive coal consumption. It was one of the most valuable documents presented, and should have earnest attention, because locomotives are larger than they used to be. The conclusions of the committee, of which Mr. H. T. Herr was chairman, are presented here, and it is hoped that they will be carefully studied, particularly with reference to the remarks concerning firemen and the proper maintenance of locomotives. The conclusions are as follows:

The increase in efficiency of enginemen and firemen in road service depends largely upon the employment of suitable material to fill the position of fireman. For numerous reasons proper consideration has not in the past few years been given to this matter, and this has led to diminished efficiency in coal consumption, influenced by the method generally followed of pooling the engines without proper facilities to maintain them in such handling.

The relatively large boiler results in economy, as indicated in the body of the report, not only in itself, but also economy in the engine, so that it is desirable to have as large a boiler as the limitations imposed by the engineering department will warrant for any particular design of locomotive.

The grate area of the locomotive boiler should be limited to a certain rate of combustion per square foot of grate, and small decrease in efficiency in boilers is obtained by increasing the rate of combustion within a maximum limit of 120 lbs. of coal per square foot of grate per hour, yet, due to the fact that with a slow rate of combustion, a milder draft will serve from the standpoint of the locomotive actually moving the train (assuming the same efficiency of firing obtains), the large grate with a slow rate of combustion has an advantage in increasing the efficiency of the engines.

The loss of fuel at delays is probably greater as the area of the grate increases and is in a measure offset by the fact that with a large grate a large engine is expected, resulting in operating fewer trains to move a given tonnage, and consequently diminishing such delays, which would have a tendency to counterbalance the increased fuel consumption due to increased grate area, leading to the conclusion that there should be a design of grate of sufficient area to give a certain rate of combustion in order to generate the requisite amount of steam to develop a given power which would be a compromise between loss due to delays and at terminals from the large grate and the loss in efficiency while running due to the smaıı grate.

The introduction of designs of locomotives with a larger proportion of the weight on trucks and trailers has resulted in efficient performance as regards fuel economy, for both boiler and engines, has been illustrated by consideration of the B engine in the report, and generally with this design the capacity of the boiler is relatively increased in proportion to the available power developed by the cylinders (which is limited by the weight on drivers), and consequently such designs would be best adapted to give efficient performance where a relatively high horse-power is to be maintained for a comparatively long time, such as, for instance, in passenger service or in through-freight service.

The relative worth of a large unit of power to a small unit warrants the maintenance of large engines to a higher standard than small engines, and to accomplish this proper facilities should be provided.

The methods of comparison of locomotives in road service from a standpoint of fuel economy should be such as to eliminate as far as possible the influence of variable conditions which might lead to erroneous conclusions from statistics now compiled, remembering that the value of fuel consumption should be proportional to the power developed by the locomotive.

FAST TRANSIT IN ENGLAND AND FRANCE.—The total number of runs scheduled at 55 miles per hour, or upward, from start to stop, is 53 in Great Britain and 35 in France.—*Rous-Marten in The Engineer.*

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL, Business Manager.

W. C. TYLER, Manager Eastern Dept.

140 NASSAU STREET, NEW YORK.

G. M. BASFORD, Editor.

R. V. WRIGHT, Associate Editor.

OCTOBER, 1904.

**Subscription.**—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscription for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill. Damrell & Upham, 283 Washington St., Boston, Mass. Philip Roeder, 307 North Fourth St., St. Louis, Mo. R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa. Century News Co., 6 Third St. S., Minneapolis, Minn. Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C., London, England.*

EDITORIAL ANNOUNCEMENTS.

**Advertisements.**—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

**Contributions.**—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

**To Subscribers.**—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

In this issue appears the first of the series of articles on economical operation of locomotives by Mr. G. R. Henderson. It indicates the nature of the study and character of the method employed in determining the most efficient rating of locomotives. The author bases his investigation upon original figures from tests made by himself, and presents factors relating to wages from schedules now in use on prominent roads with which he has been connected. Such an analysis, if made before, has never been published. It is commended to the attention of operating officials in the hope that they will examine their own practice by its aid. Unless some such examination is undertaken it is impossible to take the measure of the efficiency of train operation or to know what locomotives are doing.

A new roundhouse is being constructed on one of the trunk lines, and is to have the distinction of providing four drop pits for driving wheels. This seems like a somewhat startling suggestion, but it is justified, for the reason that when a locomotive comes into the terminal requiring work on driving boxes, or which, for any other reason, requires the wheels to be dropped, it should not be necessary to wait a moment in order to get this work under way. One or two drop pits are not sufficient for a terminal handling one hundred or more engines, and as these conveniences do not cost much the proposition of four seems to be an excellent idea. This is, by the way, a step indicating the increasing importance of the roundhouse in connection with running repairs, and it would be difficult to provide too many, or too good, facilities for accelerating the work which must be done at the end of runs. The roundhouse is frequently one of the weakest points in the matter of equipment and organization, and the tendency indicated by the attitude of the road referred to is interesting and significant.

If all cases of unsatisfactory service of compound locomotives were investigated, as in the instance described by Mr. Kinsell in this issue, perhaps compounds, as a type, would have a better name. Roads on which locomotives are specially well cared for have generally found compounds very satisfactory. It is not to be supposed that the valve motion of two-cylinder compounds are often as badly askew as Mr. Kinsell describes, but this is a noteworthy example of the possibilities. It is exceedingly important to know what locomotives are doing, whether simple or compound, and more railroads would now be enjoying the advantages of compounding if the diseases of the type had been more skillfully diagnosed and patiently treated.

## STEEL PASSENGER CARS.

Fireproof passenger cars are in service in the New York subway. They are probably not perfect in all respects, but as new cars they are exceedingly creditable, and are worthy of the attention of car builders the world over. The design throughout is novel and interesting, particularly the disposition of the floor. Continuous service may develop valuable information about fireproof cars, and it will not be strange if changes are made in future construction. The steel frame passenger car, however, has become a fact, and the starting point for cars of heavier service has been reached. In this an important step has been taken. Mr. Gibbs has shown that the problem of weight in metal construction can be overcome, and there is reason to hope that steel cars may be made which will be both stronger and lighter than present wooden ones. In view of the great weight of modern passenger equipment per passenger carried, this subject should not be lightly passed over by railroad managements.

## MASTER MECHANICS AND SHOP SUPERINTENDENTS.

Nothing in connection with the maintenance of locomotives has multiplied as fast, with the recent advance in size and capacity, as the boiler work. This is not alone due to the fact that boilers are larger and locomotives are worked harder than they used to be, but also to the fact that the proportion carrying relatively low pressure is rapidly becoming less and less. While boilers carried only 150 lbs. pressure it was comparatively easy to patch and repair them, but pressures of 200 lbs. are an entirely different matter; not only is it necessary to provide better boiler shop facilities and increased force, of the utmost obtainable skill, but every effort should be taken in the operation of the locomotives to reduce as much as possible running repairs.

On one of the trunk lines the boiler work recently increased to an alarming extent, and one of the best master mechanics on the road was detailed to give his entire attention for a time to efforts in the direction of keeping down boiler repairs. In a vigorous campaign, and by the aid of roundhouse foremen and road foremen of engines, he rearranged the methods of washing out boilers and cleaning fires at ash pits. He also systematized the use of soda ash in the locomotive tanks, and in the space of two months found it possible to reduce the roundhouse boiler repairs by over 50 per cent. This was done without the special expenditure of a cent of money, it being the result of placing this important matter in the hands of an official who was thoroughly capable of handling it, and the officers of that road were quite satisfied that it paid. So impressed are they with the importance of looking after boiler and other running repairs, in connection with the operation of the locomotives on the road, that it has been decided to appoint a superintendent of shops for each shop on the system and enable the master mechanics to devote more of their attention to the operating problems of their department.

The writer is frequently asked for suggestions with respect to roundhouse organization. The road referred to in these paragraphs seems to be on the right track. Every railroad now has sufficient organization for its roundhouses, the diffi-

culty being that the men who are capable of looking after these important factors are also expected to handle shop problems through a general foreman. The proper course seems to be to divide the work to permit the master mechanic to spend his time on the road problems and provide him with a competent assistant to follow the infinite details of each shop.

It may be asked, Why not reverse matters, putting the master mechanic in charge of the shops and provide outside foremen for the road work? As the executive officer the master mechanic should be closest to the executive work and that which comes in contact with the operating officers of the road; on the other hand, the one who is directly responsible for the shops should never be asked to attend to anything else; the master mechanic, however, by personally getting into close contact with the roundhouse and locomotive operation can, if necessary, take the ultimate responsibility for the shop as well as running repairs, if he is adequately assisted.

The shop superintendents may report directly to the superintendent of motive power, or, if the road is large enough, through a general shop superintendent to the chief of the department. No matter how this is done, the master mechanics should not be expected to devote their personal attention to shop details, and at the same time keep locomotives going on the road.

## RAILWAY APPLIANCE EXHIBITION.

Plans for an exhibition of railway appliances in connection with the approaching convention of the International Railway Congress, to be held in Washington next spring, are matured. The general committee of arrangements has organized, with Mr. George A. Post as chairman; Mr. Charles A. Moore, treasurer, and Mr. J. Alexander Brown, secretary, the committee consisting of thirty-five gentlemen representative of the strongest elements in the field of American manufacture of railroad equipment and supplies. The movement originated at the recent Saratoga convention of the railroad mechanical associations, and the preliminaries have been arranged as outlined in a report, a copy of which has been received from Mr. Post.

The exhibition itself is now to be organized, and without doubt this will be easily accomplished. The only apparent obstacle is the necessity for legislative action, in order to secure the use of the only space available in Washington for such a purpose. This is known as the "White Lot," situated back of the White House grounds, upon which no temporary buildings may be erected without an act of Congress. As precedents for the contemplated use of the ground are not lacking the necessary authority will probably be granted, providing those interested exert themselves sufficiently to induce their representatives in Congress to take the necessary action.

Over 500 foreign railroad officials are expected to attend, this being the first meeting of the organization in this country. They include the administrative, mechanical, operating and maintenance of way officials of the progressive railroads of the world. No such opportunity has ever presented itself for an exhibition of the railroad equipment and devices of this country, and a most important display is assured. Those who have given the high educational as well as commercial value to the annual exhibits at the Master Mechanics' and Master Car Builders' conventions may be trusted to embrace this opportunity to secure attention in the railroad markets of the world. If the exposition is what it ought to be it will constitute one of the most important features of the congress in bringing so many foreigners face to face with the most advanced American railroad practice.

A turbine air compressor was exhibited by Mr. C. A. Parsons at a recent meeting of the Institute of Civil Engineers (England). *Engineering* says it is capable of supplying 18,100 cu. ft. of air per minute at a pressure of 12 ins. The turbine is apparently one of the latest type, the casing being of uniform diameter throughout.

## THE CROSS-COMPOUND LOCOMOTIVE.

### DISTRIBUTION OF POWER.

BY W. L. KINSELL.

An equal distribution of power on both sides of a cross-compound locomotive is possible, with the valve motion used at present, only through a short range of speed and a small variation of cut-off. For this reason such an engine should be assigned to a certain class of road work, and the valve motion should be adjusted so that under average conditions the work done on one side of the engine will be equal to that done on the other. A test of a two-cylinder compound on the Norfolk & Western Railway, so arranged that it could be worked either simple or compound and in which the power was quite equally distributed over a wide range, was described in the June, 1898, issue of your journal.

The following tests, made on the Chicago, Great Western Railway, emphasize the necessity for a careful study of the power distribution of these engines by the mechanical departments under whose care they come. Following are some of the dimensions of the locomotive tested:

| | |
|---|---|
| Type | 2-6-2 |
| Diameter of drivers | 63 ins. |
| Diameter H.P. cylinder | 22 ins. |
| Diameter L.P. cylinder | 35 ins. |
| Stroke | 28 ins. |
| Weight on drivers | 135,500 lbs. |
| Weight of engine | 189,500 lbs. |
| Clearance per cent. head end H.P. cylinder | 22.74 |
| Clearance per cent crank end H.P. cylinder | 22.98 |
| Clearance per cent head end L.P. cylinder | 10.71 |
| Clearance per cent crank end L.P. cylinder | 10.42 |
| Grate area | 49.3 sq. ft. |
| Heating surface | 3,225 sq. ft. |
| Sq. ft. damper opening in ash pan | 3.25 |
| Throw of eccentric | 6 ins. |
| Steam lap H.P. cylinder | 1¼ ins. each end |
| Exhaust lap H.P. cylinder | 3-16 in. clearance each end |
| Steam lap L.P. cylinder | 1 in. each end |
| Exhaust lap L.P. cylinder | ¼ in. clearance each end |

The first test showed that the engine as delivered by the builders was not in condition to economically do the work to which it was assigned. The power developed on the two sides came the nearest to being equalized when the engine was running slowly at a long cut-off, but even then the work done on the low-pressure side was nearly 40 per cent. greater than that done on the high-pressure side, and this difference became greater as the speed increased and the cut-off decreased until, at high speed, all of the work was being done on the low-pressure side, and, as the throttle was opened wider, work was actually being done against the high-pressure piston. With the boiler pressure at 200 lbs. the steam was exhausted into the receiver at about 70 lbs. pressure without doing any effective work, and this of course would indicate a large loss.

| | Test 1. | Test 2. |
|---|---|---|
| Number of miles run | 162 | 150.8 |
| Actual running time | 7 hrs. 57 mins. | 8 hrs. 33 mins. |
| Average speed per hour, not including stops | 20.37 | 17.64 |
| Number loaded cars | 31 | 25 |
| Number empty cars | 1 | 1 |
| Total tonnage back of tender | 961 | 982 |
| Pounds water evaporated at 52 degrees F. | 142,470 | 126610 |
| Pounds coal burned | 20,400 | 25530 |
| Pounds coal burned per ton mile | .131 | .153 |
| Pounds water evaporated per ton mile | .915 | .815 |
| Pounds water evaporated per lb. coal | 6.98 | 5.62 |

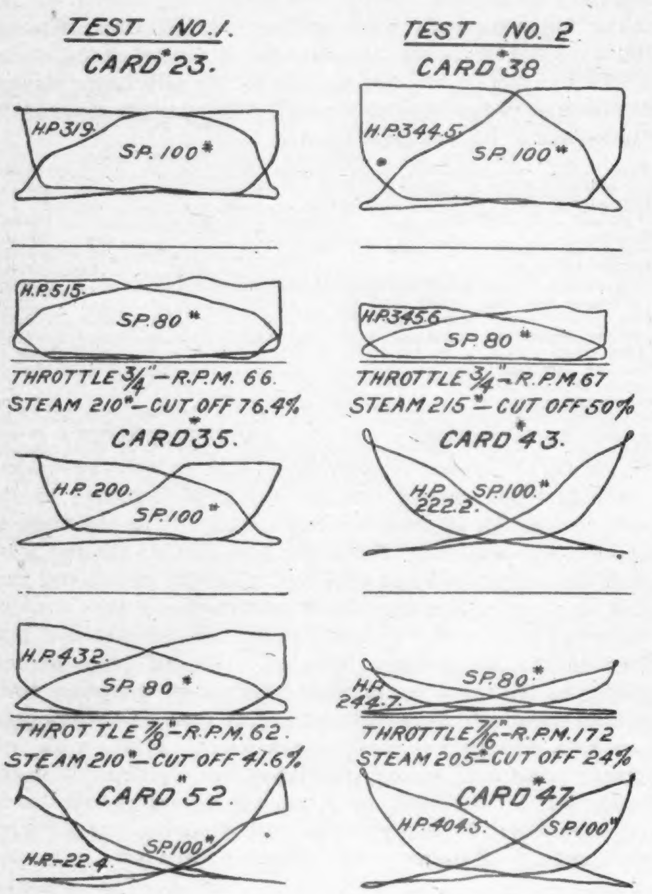
Forty indicator cards taken under normal conditions showed that 70 per cent. of the work was being done on the low-pressure side, or on the average 2⅓ times as much pressure was being exerted on the main pin on that side than on the other. This was quite noticeable, as the temperature of the main pin on the low-pressure side was considerably higher than that of the other.

The engine had a piston valve with outside admission, the body of the valve being 1/32-in. smaller than the bore of the bushing. On the first test the ring on the cut-off side of the high-pressure valve was broken, and card 35 taken at 41.6 per cent. cut-off with a ⅞-in. throttle opening and a speed of 11.3 miles per hour, plainly shows that as soon as the exhaust edge of the valve closed the port and compression began the steam blew through the ring where the piece was broken out and increased the compression to the initial pressure when the piston was more than 2 ins. from the end of its stroke. The cut-off

point is not very clearly marked, the steam blowing through the broken ring until the exhaust port opened to the receiver. The crank end card is very good, the packing rings in that end of the valve being in good condition. This card shows that only 31.6 per cent. of the work was done on the high-pressure side.

Card 23, taken at 76.4 per cent. cut-off, 1¼-in. throttle opening, at a speed of 12 miles per hour, shows that the high-pressure cylinder was doing only 38.2 per cent. of the work. Card 52, taken when running 36.2 miles per hour, with an 18 per cent. cut-off and ⅜-in. throttle opening, shows that work was actually being done against the high-pressure piston.

After this test the valve motion was adjusted by taking a low-pressure card when running under normal conditions and adjusting the cut-off on the high-pressure side so that the high-pressure cylinder would deliver to the receiver that amount of steam at a pressure which would cause the same amount of




INDICATOR CARDS.—CROSS COMPOUND LOCOMOTIVE.

work to be done in the low-pressure cylinder. The proper cut-off on the high-pressure side was obtained by shortening the high-pressure link-hanger 9/32 in., since it was desired to reduce the work done in the low-pressure cylinder faster than in the high-pressure.

The broken high-pressure ring was renewed and another test made over the same division with very satisfactory results. On this test the speed varied from 5 miles per hour, at which the slowest card was taken, to 40 miles per hour, at which speed several cards were taken, the throttle opening varying from ¼ in. to 2 ins. and the cut-off varying from 12.7 to 82 per cent., the engine running under normal conditions. In this large range of speed, cut-off and throttle-opening the largest variation in work done in each cylinder was 44 per cent. on the high-pressure, with 56 per cent. on the opposite side, while the average per cent. of work done in each cylinder throughout the whole test was 50, showing that the power was properly distributed for these conditions. Comparing the high and low-pressure cards taken on the second test, it will readily be seen that the desired result had been accomplished; card 38, taken at one-half cut-off, and under average conditions, shows a good distribution of power. On card 43, taken at a comparatively high speed and a small throttle opening, and on card 47, taken at a still higher speed with a larger throttle opening, the power is not so evenly distributed.

This test was made with the same train crew as the first, but the weather was very stormy, which should cause an increase in the pounds of water evaporated per ton mile, but comparing the two tests reveals a decrease of 0.1 lb. of water per ton mile for the second, or a saving of 15,568 lbs. of water over the first test, which, at 6.98 lbs. per lb. coal, would cause a decrease in coal burned on the trip of 2,230 lbs., or a saving of at least one ton. On the second test the coal was not as good as on the first, the time of stops longer, and the speed slower, which all go to decrease the evaporation factor of the boilers, yet the amount of water used per ton mile was 11 per cent. less than on the first, showing very plainly that small defects in valve motion will cause a large loss in steam and indirectly a loss in dollars and cents. Although the high-pressure valve cuts off earlier than before with the same position of reverse lever and the valve travel is shorter, the increased wire drawing is not noticeable, and the low-pressure valve has the same travel as before with a large port opening. The engine now hauls the same tonnage as before, more smoothly and much more economically, thus fully demonstrating that the compound locomotive valve motion, if not adjusted properly, can cause a large loss in fuel consumption.

## VARIABLE SPEED MOTORS IN RAILWAY MACHINE SHOPS.

BY J. C. STEEN.

In railway machine shop work, as in commercial establishments, it is necessary to secure as large an output as possible with the lowest expenditure of time and money consistent with a good quality of work. With this end in view it is sometimes advisable to improve certain machine tools as well as the methods of operating them. For instance, with the improved tool steels machine tools can be operated at a much higher rate of speed than former practice required or permitted.

The work to be done may be such that it is only necessary to use higher speeds, already provided for in the machine; but when it is general in character and a comparatively wide range of speeds is required at the higher rate, some more modern and efficient means of driving must be looked for than from the usual belt drive, and the best alternative in such cases is to apply a motor directly to the machine. In many cases the various parts of the machine will be found strong enough to stand the work, but the increased speed at which the cuts are taken demands a proportionate increase in the amount of power expended, and this may overtax the belts and shafting, perhaps already well loaded. The simplest remedy in such a case is to isolate the machine and apply an individual motor. Such a change from the usual methods of driving involves the consideration of some arrangement by which the necessary variation of speed can be obtained. In this connection, it is assumed that the shop is already provided with a direct-current single-voltage system, and from this source the desired variable-speed drive is to be obtained. With the single-voltage system and a constant-speed motor as the only available source of power, the user naturally hesitates about applying a motor-drive to the machine, because of the necessity of securing speed variation by some system of gearing more or less complicated, according to conditions. With the variable-speed motor, however, the amount of gearing employed is reduced to a minimum, and in some cases may be dispensed with altogether and the entire variation in speed be secured from the motor alone.

Variable-speed motors can now be obtained that have been designed especially for use with the single-voltage system, and

are not only simple in construction but very efficient in operation, and thus the problem of individually driving old machine tools is much simplified. Wherever the variation required is too great to be secured through the motor alone, change gears can be introduced, and almost any variation of speed can be had within reasonable limits. The relation between the motor speed variation and the ratio of gear changes, where gears are used, should, of course, be such as will give the proper succession of speeds through both runs.

Compared with a constant-speed motor, one with a variable-speed has the additional advantage that speed variation can be much more easily secured through the manipulation of a controller handle than by any other means; and, as compared with the belt drive, this method of speed variation is obviously so far superior to belt shifting that the saving of time, not to mention temper and the wear and tear of the operator's mental disposition, tends very much to an increased output. Frequently the increased output secured, due to more efficient operation of the machine, is sufficient to pay for the entire outlay in a very reasonable time.

Many hesitate regarding the consideration of changes in existing driving mechanism, owing to the amount of work involved in making the change. The problem is to bring about a change in the least expensive manner and at the same time to secure an arrangement that will be efficient in action and simple in operation. Any device that involves undue complication of parts is to be avoided when possible. Individual driving of machine tools, by well designed and properly selected variable-speed motors, is one of the means by which some of the vexing problems of shop management are solved; and such drives can readily be applied to machine tools, either new or old.

The variable-speed motor has been developed in response to a demand for progressive appliances, and the fact that such a motor can be used with a single-voltage system gives it many advantages over more complicated systems.

## THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

BY R. V. WRIGHT.

MCKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

XIV.

This article completes the description of the application of motors to the old machine tools at the McKees Rocks shops, and although the machines described have been in service about a year and during that time high speed tool steels and commercial methods have been introduced into the shop as rapidly as possible, yet practically all of them have given good satisfaction. In a railroad repair shop there is a large amount of work that does not require heavy roughing cuts, and the old tools, if in good condition, can handle this class of work nicely, although running at a considerably higher cutting speed than they were designed for. Again, although the machines are spoken of as old, because they were used in the old shops, several of them were purchased during the year or two just preceding the building of the new shops, and are of good modern design.

Fig. 63 illustrates a motor application to a D. Saunders' Sons IXL pipe cutter. The belt pulley was replaced by the large Morse silent-chain sprocket, and the motor was set on a 4-in. oak block on the floor and covered with a casing to protect it

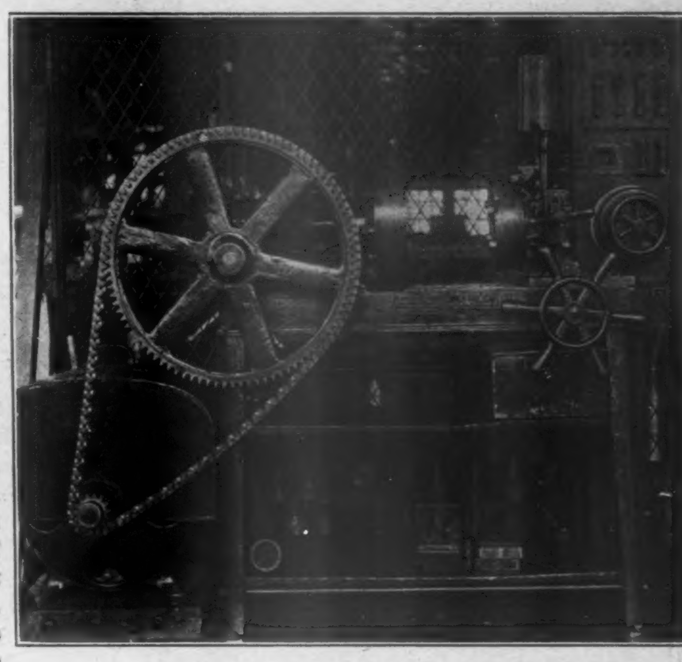


FIG. 63.—MOTOR DRIVE APPLIED TO SAUNDERS IXL PIPE CUTTER.

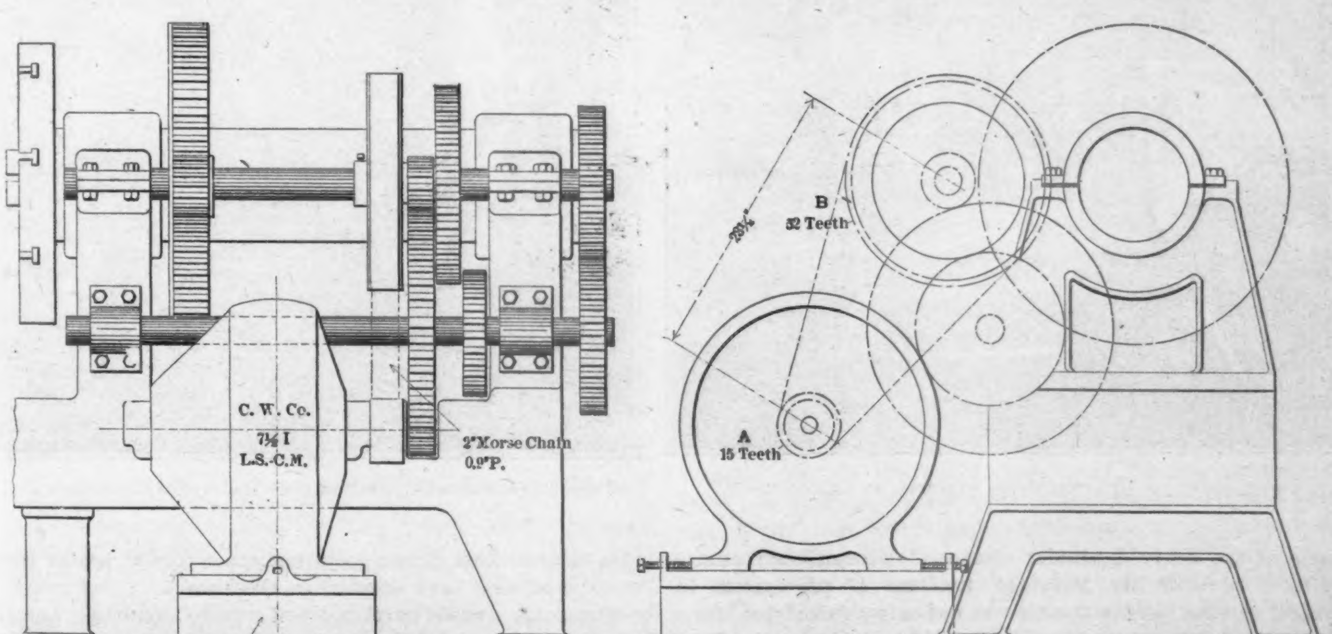



FIG. 64.—MOTOR APPLIED TO NO. 5 SAUNDERS SONS' PIPE CUTTER.

from oil and dirt. In the upper right hand corner of the half tone is shown the panelboard that holds the switch, fuse block and controller. The controller is an M.Q. 6 type made by the Crocker-Wheeler Company, and furnishes six speeds, or one for each of the voltages of the 4-wire system. This machine has a maximum speed of 107 revolutions per minute and is driven by a Crocker-Wheeler Company 3 h.p. motor.

A motor application to a Saunders Sons' pipe cutter No. 5, which has a capacity for pipe up to 6 ins. in diameter, is shown in Fig. 64. In this case the motor was set on oak blocking on the floor at the rear of the headstock end of the machine and connected by Morse silent-chain to a sprocket which replaced the speed cone used with the belt drive. The motor is a Crocker-Wheeler Company 7½ h.p., and is operated by an M.F.-21 controller. The machine itself has three runs of gearing, and this, in connection with the motor, gives a wide range of speed.

The motor application to a 200-ton Niles wheel press, which will take up to 72-in. wheels, was very simply made, as shown in Fig. 65. The large belt pulley was replaced by a sprocket that is connected by a Morse silent-chain to the motor, which is bolted to oak blocking on the floor to the right of the machine. The pump is run at a constant speed of 165 strokes per minute and the motor is a Crocker-Wheeler Company 7½ h.p. The panelboard for the starter, switch and circuit-breaker is placed at the extreme right, where it is out of the way of the wheels and axles but convenient to the operator.

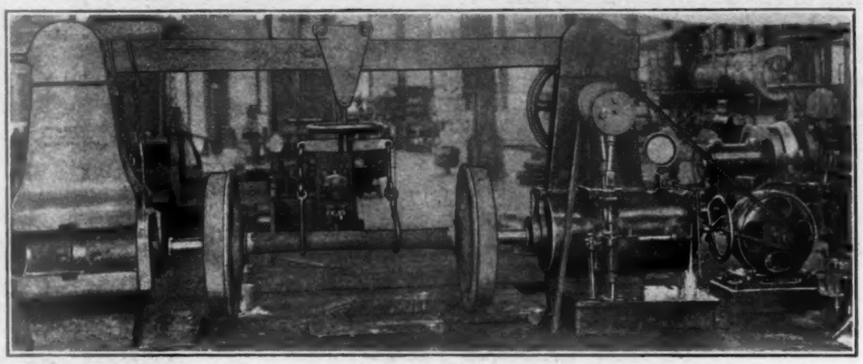


FIG. 65.—MOTOR DRIVE APPLIED TO NILES WHEEL PRESS.

## METHOD OF REPAIRING CRACKED CYLINDERS.

MICHIGAN CENTRAL RAILROAD.

The accompanying engravings illustrate a novel and effective method of making a permanent repair upon some cracked cylinders, that was resorted to at the Jackson, Mich., shops of the Michigan Central Railroad. Trouble was experienced with breakages of the high-pressure cylinders of some of the heavy 2-cylinder compound locomotives that are being used upon the Michigan divisions of the system in freight service, but the trouble was not only checked but taken care of by the following method of strengthening these cylinders:

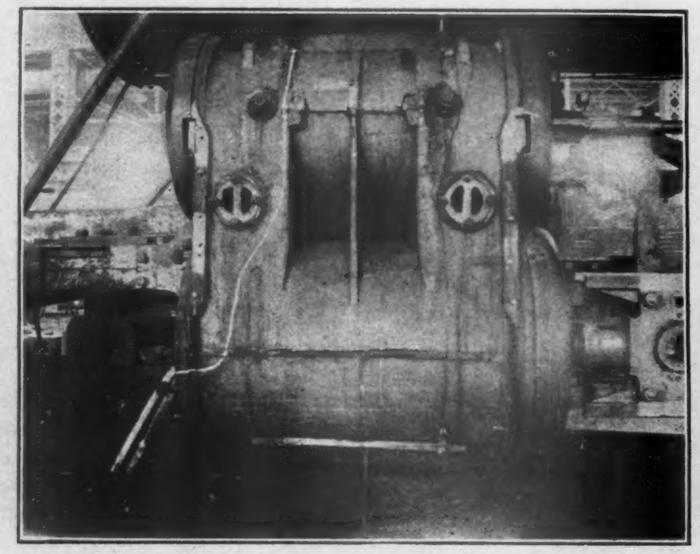


FIG. 1.—ONE OF THE CYLINDERS STRIPPED TO SHOW CRACK.

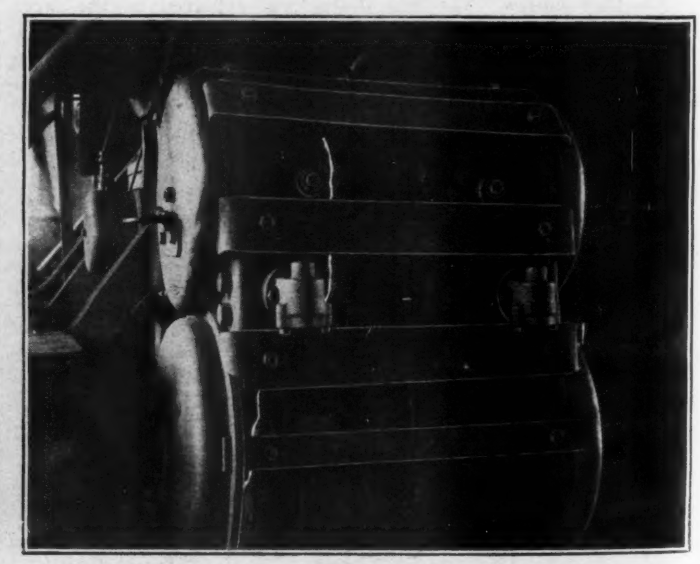


FIG. 2.—CYLINDERS AFTER BRACES HAVE CLOSED UP CRACK.

Fig. 1 shows the location and character of the cracks that took place. In all of the several cases of breakage, the crack started on the upper side of the piston-valve case, just at the rear of the forward ports, and extended around and downward, curving forward and ending at the front edge of the cylinder at or near its horizontal diameter. It has been impossible to assign a cause for this cracking, as the cracks usually developed slowly until at length destruction of the entire cylinder was threatened.

The method of repairing adopted was a very simple and effective expedient, and its worth has been proven in service, as no further trouble has been experienced since these repairs. As may be seen from Fig. 2, heavy wrought iron bars were forged with right-angle bends at each end, forming fixed clamps; the distances between the jaws were made somewhat less than the lengths of the cylinder castings outside. The bars were then heated and slipped, while red hot, over the edges of the castings as shown in Fig. 2; when cooled they shrunk onto the casting so tightly as to effectively and completely close up the crack.

This has been done on all the engines upon which cylinders have cracked, and with universally good results. The cylinder shown in Fig. 2 is one that had appeared beyond hope of repair, but it has now been in service over a year. In one of the first cases it was found necessary to brace the cracked portion of the port chamber from within, which was done by means of jacks placed between the vertical partitions and the walls of the steam passage leading to the by-pass valves. This gives a solid resistance for the braces which would otherwise have no effect on these walls.

Since this trouble developed and was so effectively reduced, the high-pressure cylinders of all of the remaining 2-cylinder compounds of similar class have been strengthened by the application of similar binding bars shrunk in place. On those which have not cracked, however, only two bars are applied,

one above and one just below the two relief valves shown. The remarkable feature of this work is that these bars are so located as not to interfere with the cylinder covers or to prevent the application of the cylinder lagging. The cylinder covers were chipped out sufficiently to clear the braces, where they project over the edge of the cylinder casting.

We are greatly indebted for this information to Mr. D. R. McBain, master mechanic, and to Mr. M. D. Franey, foreman, of the locomotive shops at Jackson, to whose originality this interesting and effective method of repair is due.

## AMERICAN RAILWAY APPLIANCE EXHIBITION.

### To Be Held in Washington.

The Railway Supply Men's Association inaugurated a movement at Saratoga last summer which led to the passing of a resolution authorizing Mr. George A. Post, chairman of the meeting, to appoint a committee to prepare for and conduct an exhibition of railway appliances at Washington during the convention of the International Railway Congress in that city May 3 to 13 next. This selection of the committee was made by Mr. Post and at a meeting held September 8 the committee organized with the following officers and members:

CHAIRMAN, GEORGE A. POST, President Standard Coupler Company, New York.
TREASURER, CHARLES A. MOORE, Manning, Maxwell & Moore, New York.
SECRETARY AND DIRECTOR OF EXHIBITS, J. ALEXANDER BROWN, The Pocket List of Railway Officials, New York.
H. P. BOPE, Vice-President Carnegie Steel Company, Pittsburg.
J. B. BRADY, Vice-President Standard Steel Car Company, New York.
L. F. BRAINE, General Manager Continuous Rail Joint Company of America, Newark, N. J.
J. A. BRILL, Vice-President J. G. Brill Company, Philadelphia.
A. E. BROWN, Vice-President Brown Hoisting Machinery Company, Cleveland, Ohio.
C. A. COFFIN, President General Electric Company, New York.
O. H. CUTLER, President American Brake Shoe & Foundry Company, New York.
F. H. EATON, President American Car & Foundry Company, New York.
HARRY ELLIOTT, JR., Vice-President Elliott Frog & Switch Company, St. Louis.
WILLIAM GOLDIE, SR., William Goldie, Jr., & Co., Pittsburg.
H. S. HAWLEY, President Railroad Supply Company, Chicago.
F. N. HOFFSTOT, President Pressed Steel Car Company, Pittsburg.
A. B. JENKINS, Jenkins Bros., New York.
ALBA B. JOHNSON, Baldwin Locomotive Works, Philadelphia.
B. F. JONES, President Jones & Laughlin Steel Company, Pittsburg.
A. M. KITTREDGE, Vice-President Barney & Smith Car Company, Dayton, Ohio.
WILLIAM V. KELLEY, President Simplex Railway Appliance Company, Chicago.
E. B. LEIGH, Vice-President Chicago Railway Equipment Company, Chicago.
WILLIAM LODGE, President Lodge & Shipley Machine Tool Company, Cincinnati.
GENERAL CHARLES MILLER, President Galena-Signal Oil Company, Franklin, Pa.
FRANKLIN MURPHY, President Murphy Varnish Company, Newark, N. J.
D. C. NOBLE, President Pittsburg Spring & Steel Company, Pittsburg.
H. S. PAUL, President Verona Tool Works, Pittsburg, Pa.
A. J. PITKIN, President American Locomotive Company, New York.
ALFRED A. POPE, President National Malleable Castings Company, Cleveland, Ohio.
H. KIRKE PORTER, H. K. Porter & Co., Pittsburg.
W. W. SALMON, President General Railway Signal Company, New York.
C. W. SHERBURNE, President Star Brass Manufacturing Company, Boston.
H. A. SHERWIN, President Sherwin-Williams Company, Cleveland, Ohio.
C. A. STARBUCK, President New York Air Brake Company, New York.
ALBERT WAYCOTT, Vice-President and General Manager Damascus Brake Beam Company, St. Louis.
H. H. WESTINGHOUSE, Vice-President Westinghouse Air Brake Company, Pittsburg.
WARD W. WILLITS, Vice-President Adams & Westlake Company, Chicago.

With these gentlemen in charge the exhibition is sure to be a complete success. Such an opportunity of displaying American railway appliances to 500 or more foreign officials, coming as they will to represent their roads, has never been offered before. Such difficulties as remain to be removed will doubtless be easily disposed of, such, for instance, as the provision of suitable space for the exhibition. This subject is mentioned editorially elsewhere in this issue.

## IMPROVED TOOL STEELS.

The following table and statement showing the effect of the alloy tool steels on the cost of output for turning a pair of old and badly worn standard driver tires 70 ins. in diameter is taken from a paper read by Mr. W. R. McKeen, Jr., before the recent convention of the Master Mechanics' Association:

COMPARATIVE COST OF OUTPUT FOR ONE PAIR OF DRIVING WHEELS.

| Operation. | Carbon. Hrs. Min. | Air Hardening. Hrs. Min. | High Speed. Hrs. Min. | Carbon. | Air Hardening. | High Speed. |
|---|---|---|---|---|---|---|
| Setting tool, etc., throughout job. | 1:30 | 1 | :36 | $0.50 | $0.33 | $0.20 |
| Grinding roughing tool......... | 1:30 | 1 | :20 | .50 | .33 | .11 |
| Grinding flanging tool.......... | 1:30 | 1 | :04 | .50 | .33 | .02 |
| Roughing cut................ | 8 | 5 | 1:00 | 2.65 | 1.65 | .33 |
| Finishing cut................ | 5 | 2:30 | :30 | 1.65 | .83 | .17 |
| Flanging cut................ | 2:30 | 1:30 | :30 | .85 | .50 | .17 |
| Total labor................ | 20:00 | 12:00 | 3:00 | 6.65 | 3.97 | 1.00 |
| Interest, depreciation, repairs, etc., figured at 15% on first cost, per hour........ | | | | (.13) | (.13) | (.40) |
| per job | | | | 2.60 | 1.60 | 1.20 |
| Power, at 3 cents per horse-power hour...per hour | | | | (.07) | (.12) | (.18) |
| per job | | | | 1.00 | 1.00 | .50 |
| Total fixed charges........ | | | | 3.60 | 2.60 | 1.70 |
| Total of all items........ | | | | 10.25 | 6.57 | 2.70 |

In this table, showing comparatively cost of output, it will be seen that there is not a single operation in which the new tools do not directly or indirectly effect a saving in setting and grinding tools, varying from 50 per cent. to 98 per cent. of time originally taken with the carbon steels. These savings are real gains and not mere statements on paper.

To take up the table part by part: The first line shows time consumed in setting tools; where these tools have been taken out of the holder frequently for regrinding, etc., more time will be so occupied that when practically no resetting occurs. The grinding shows up clearly the comparative durability of the tools; the old steel requiring much more frequent grinding than the high-speed or alloy steels. Grinding a carbon roughing tool will require 15 minutes (walking to and from emery wheel, etc.) and each tool will ordinarily be reground three times for each tire turned; whereas the high-speed tool will last throughout the job with one grinding. While the flanging tool does not have such severe usage as the roughing tool, it requires much greater care in grinding. With the alloy tool one grinding of same will answer for about fifteen wheels, or an average of four minutes for each pair. In the tests the flanging tool was of special design, being quickly ground to standard by tool room; the average time occupied for grinding per each pair of wheels being two minutes.

The next three items—roughing, finishing and flanging cuts—are the main economical features, and are entirely due to the high speed capacity of the new tools. It will be seen that the labor cost in the case of the high speed is only half that with the ordinary air hardening steel, and less than one-third as much as with the old carbon steel tools.

The interest, depreciation, repairs and renewals to machine and electrical equipment have been estimated at 15 per cent. on $6,000 for the modern lathe, or 40 cents per hour, and at 10 per cent. on $3,000 on old style lathe, which would be sufficiently fast for the speed capacity of the old carbon steel tools. It must be remembered, in this connection, that there has as yet been no driving wheel lathe built expressly for high-speed alloy steels.

The power (delivered to work) has been taken in all cases at 3 cents per horse-power hour, a conservative figure for conditions in the Middle West, and considering the many transmission losses.

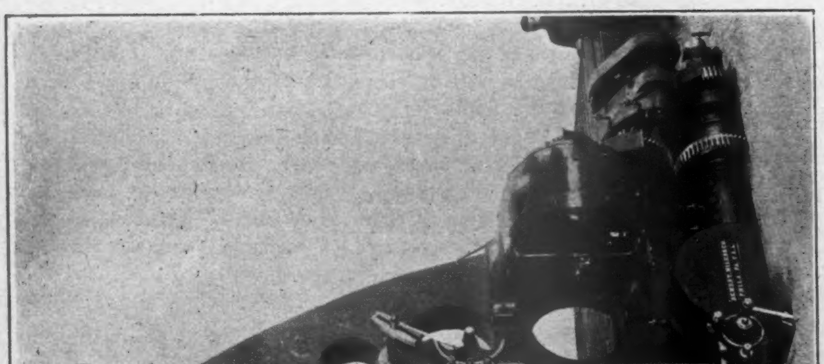


FIG. 1.—PLANER WITH PNEUMATIC CLUTCHES.—BEMENT, MILES & COMPANY.

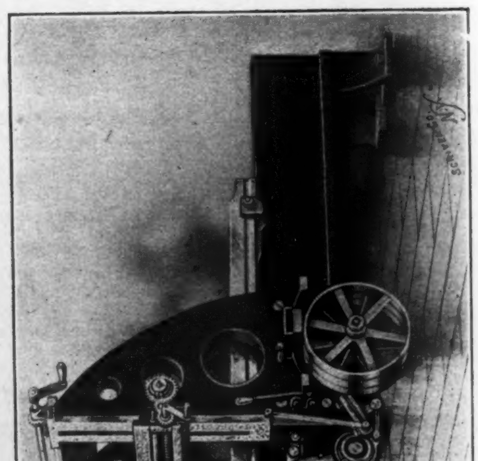



FIG. 2.—HIGH SPEED PLANER.—CHANDLER COMPANY.

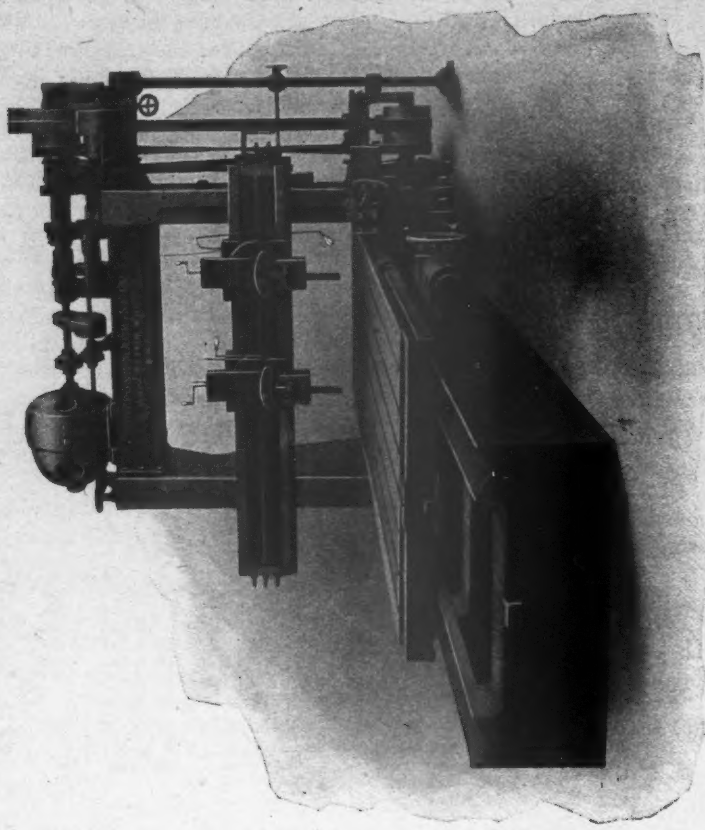


FIG. 3.—96-IN. BY 24-FT. PLANER.—L. W. POND MACHINE & FOUNDRY COMPANY.

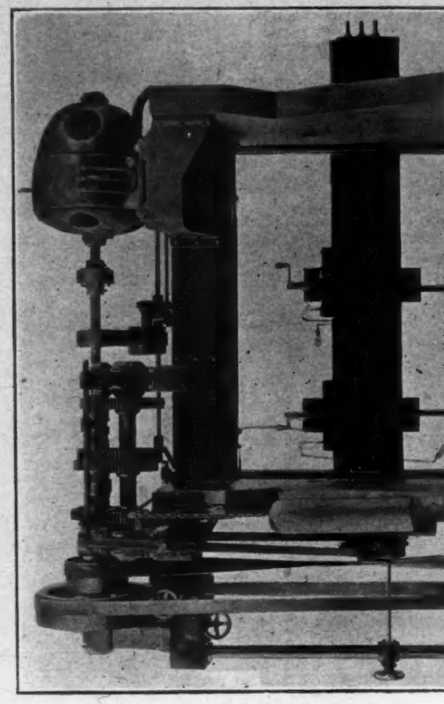


FIG. 4.—APPLICATION OF MOTOR TO L. W. POND MACHINE & FOUNDRY COMPANY'S PLANER.

## IMPORTANT IMPROVEMENTS IN PLANER DESIGN.

With the advent of high speed tool steels and individual motor drives and the stimulus they gave to improving shop methods, the question of increasing the cutting and return speeds of planers has been a perplexing one. The limitations of the ordinary type of planer had apparently been reached and the builders realized the necessity of improving their designs to meet the new requirements. Those who have followed the improvements as reported from time to time in this journel have noticed the steady progress which is being made, and that the builders have studied the question carefully is shown by the different ways in which they are overcoming the difficulty. As will be noted from the planers described in this article, some very radical changes in design have recently been made with surprising results.

The planer shown in Fig. 1, made by Bement, Miles & Co., is on exhibition at the St. Louis Exposition and is of interest because of its size, the friction clutches operated by air which reverse the table, and the application of the individual motor drives.

The width between the uprights and also the distance between the table and the crossrail when it is in its highest position is 10 ft. 2 ins. and the table, which is of very heavy construction, is 8 ft. 8 ins. wide, 30 ft. long, exclusive of the pans at each end, and runs on two V's each 12 ins. wide, which present a bearing surface of 9,000 sq. ins.

The V's are self-lubricating by means of pockets and rollers and these pockets are so connected that oil poured in one of them is equally distributed to all. The table is driven by a heavy pitched rack with a 15-in. face which engages with a large bull wheel within the bed, which is mounted together with other gearing on framework detachable from the bed.

Friction clutches operated by compressed air are used to reverse the table as the table speeds and the power required are greater than could be obtained by the use of shifting belts. These clutches, two in number, run in opposite directions and are mounted on the shafts which usually carry the pulleys. One clutch gives the forward or cutting speed to the table and is equipped with change gears in order that the cutting speed can be varied for different materials. The other clutch is arranged to give a constant speed for the return stroke, regardless of the cutting speed. A small operating valve with a lever for controlling the clutches is attached to the side of the bed and this lever is tripped by dogs on the table in a manner similar to the ordinary belt shifting device, but of lighter construction. A light and neat handle at the operator's position is provided for reversing the table travel independently of the dogs, this handle being connected with the air valve. From the valve, pipes lead to the rear end of the clutch shafts, where there is a gland and stuffing box connection for conveying compressed air through the centre of the shaft to the clutches.

The machine was designed to have a return table cutting speed of 80 ft. per minute and was tested at the shops to 100 ft. per minute. It is driven by a General Electric Company 60-h.p. motor, which is mounted on the side of the housing and is geared direct to the clutch shaft. Cutting speeds can be obtained by the change gears from 18 to 36 ft. per minute.

The uprights are 20 ins. across their faces and each has a substantial side head having automatic vertical feeds. The tool slides have 24 ins. horizontal travel and can be swiveled for angular work. An independent 3-h.p. motor mounted on the side of the machine is used for quickly traversing the side heads up and down the upright. The crossrail is 30 ins. wide on the face and is fitted with two saddles, made right and left handed for bringing the tools close together. The vertical tool slides have 30 ins. traverse and can be swiveled to any angle. The tool aprons are outside gibbed with T slots and tool clamps and have automatic tool relief operated by vertical feed spline shaft. The saddles have feeds in either direction across rail and tool slides have vertical feed in their saddles. The crossrail is made of sufficient length to permit one saddle being traversed clear of the upright and allow full traverse of the other saddle between uprights for finishing work of maximum width. At the rear of the crossrail is a 3-h.p. motor connected by gearing to screws and feed spline shaft in rail. By means of a lever and switches conveniently placed for controlling this motor, the saddles can be traversed quickly on the rail, and the tool slides vertically in their saddles. For raising and lowering the crossrail, a 5-h.p. motor is mounted on top of machine, and geared direct with the screws in the uprights.

Fig. 2 illustrates a 24-in. x 24-in. x 12-ft. planer made by the Chandler Company, Ayer, Mass., which is accomplishing wonderful results. This company guarantees any cutting speed up to 100 ft. per minute. If the cutting speed does not exceed 75 ft. per minute, the platen is returned at a speed of 200 ft. per minute. If the cutting speed exceeds 75 ft. per minute, the platen is returned at a speed of 150 ft. per minute. At these high speeds the platen reverses smoothly and without shock or jar and is operated by a belt only 1 in. wide. Three belts are necessary to accomplish this, one for driving when cutting, one for reversing and one for running the platen back at high speed.

The platen is reversed at the end of the cutting stroke by an intermediate or reversing belt, running at such a rate of speed as is practical to secure the highest and best reversal from the speed of the cut. Immediately after the platen starts back on the return stroke, the tappet encounters a second step in the dog, which throws off the intermediate or reversing belt, and throws on the high speed belt, which remains in action until near the end of the reverse stroke, when the cycle is reversed; the high speed reversing belt going off, succeeded by the intermediate belt, from which the platen is reversed to the cutting stroke. An illustration of the application of this principle is shown in the two Chandler planers now in operation. On one the cutting speed is 50 ft., the intermediate speed 90 ft., and the quick return 200 ft.; on the other, the cutting speed is 92 ft., the intermediate speed 80 ft., and the quick return 154 ft. Of the three pulleys shown in the engraving, the middle one only is tight on the shaft. The belt which drives the platen on the forward or cutting stroke runs on the outer one and the belt for reversing it runs on the inner one. The belt which operates it on the quick return is on the other side of the planer.

If the quick return is not desired, as, for instance, on an extra short stroke, where the too frequent reversing of the high-speed belts is liable to cause them to burn, or where a particularly accurate stop may be required, or where the character or exigency of the load may make a slow return speed more desirable, lifting a latch on the return dog keeps the high speed belt out of operation, and the platen is returned on the intermediate speed or reversing belt. The speed of the platen can be varied without changing the speed of the driving belts by a combination of gearing and clutches located between the pulley shaft and the bull gear, and operated by a lever. The shafts are large and are case hardened and accurately ground in order to reduce the friction to a minimum, and this is partly the cause of the excellent results obtained. The Chandler Company claims that they are the first to successfully harden such large shafts. The first planer built on the above principles, a 24-in. x 24-in. x 6-ft., has been in service five months and has been subjected to the most severe tests. In order to prove that heavier planers can be successfully operated, they have equipped and are running daily one of their planers with a platen weighing 3,750 lbs., with a load of 8,500 lbs. on it, and are operating the platen at a return speed of 200 ft. per minute with a 1-in. belt. The feed regulating device is operated by a lever moving on a marked dial convenient to the operator.

Figs. 3 and 4 illustrate a 96-in. planer with three heads and a 24-ft. table, built by the L. W. Pond Machine & Foundry Company, of Worcester, Mass., and driven by a 35 h.p. Crocker-Wheeler Company type I compound wound motor, mounted on top of the housing. It is coupled to the shaft driving the fly-wheel pulley, and the diameters of the pulleys and the gearing under the table are proportioned to give a return table speed of 70 ft. a minute with the motor running at its maximum

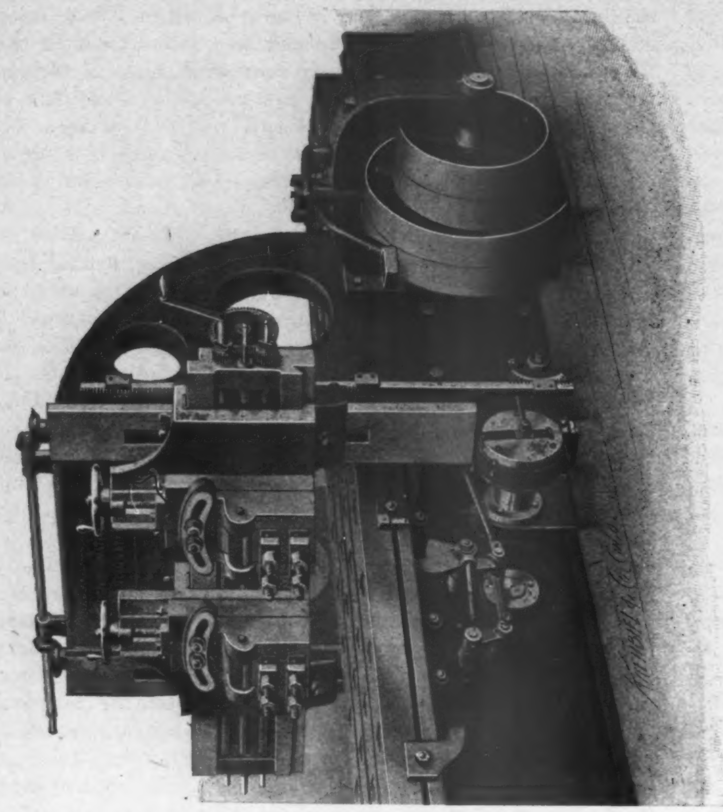


FIG. 5.—HEAVY FROG AND SWITCH PLANER.—CINCINNATI PLANER COMPANY.

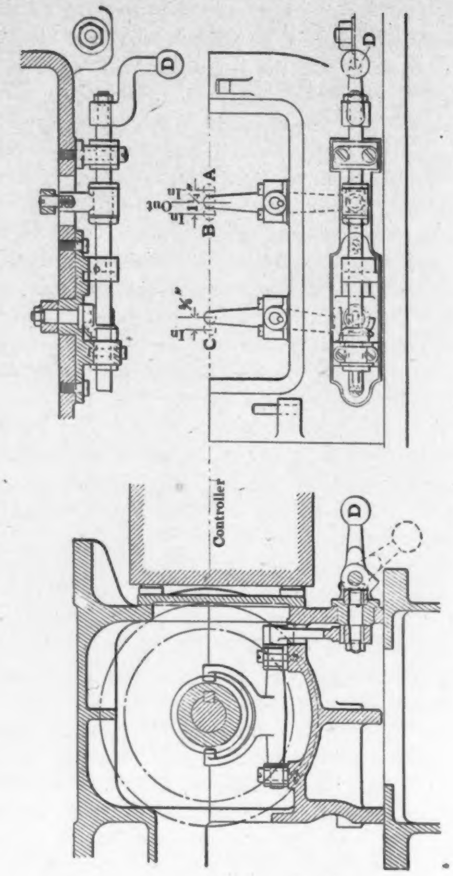



FIG. 3.—ARRANGEMENT FOR THROWING CLUTCHES.

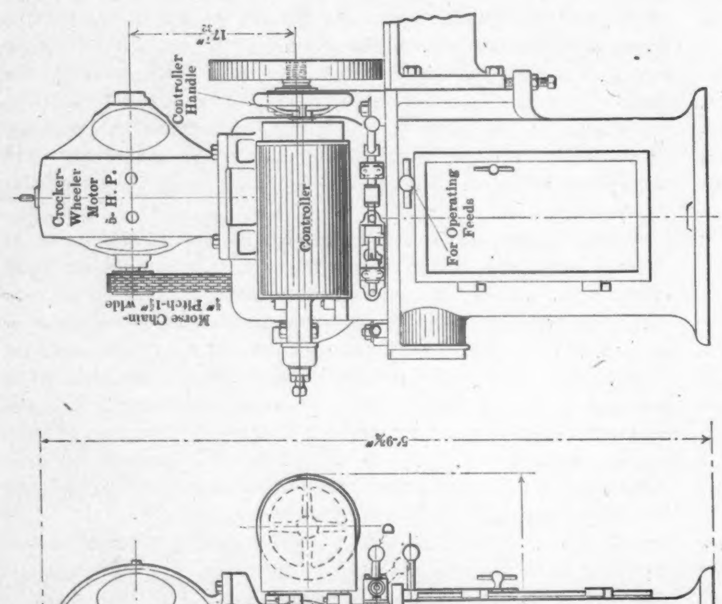



FIG. 1.—MOTOR DRIVEN TURRET LATHE.—AMERICAN TOOL & MACHINE COMPANY.

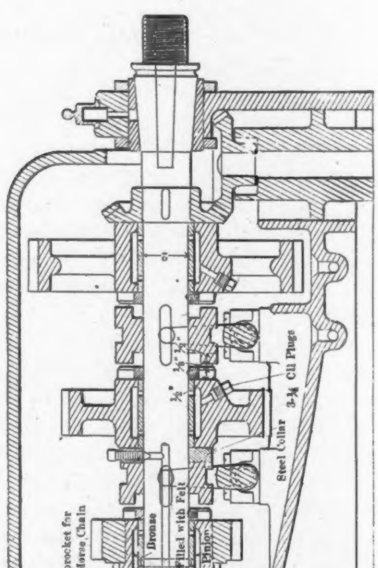



FIG. 2.—SECTION THROUGH HEADSTOCK.

speed. The upper pulley for the forward-motion belt is mounted on a sleeve concentric with the above mentioned shaft, and by means of suitable gearing and jaw clutches operated by a hand wheel conveniently placed at the side of planer, this sleeve and pulley may be driven at any one of four speeds by the inner shaft, thus giving for a return table speed of 70 ft. a minute forward speeds of 35, 27, 20 or 15 ft. a minute. The changes of speed are regulated by a dial on the hand-wheel, the latter being mounted on a shaft carrying a cam drum which operates two levers for shifting the gear-controlling clutches overhead. Each lever thus controls two speeds, and the cam and levers are so arranged that one of the levers must remain stationary while the other is moved to shift its clutch. Hence there is no possibility of both clutches being accidentally engaged at the same time. If finer cutting speed variations are desired, they are obtained by varying the motor speed.

The remarkable feature of the equipment is that the reversal of the table, even at the highest speeds, causes practically no

peak load on the motor; or stated another way, the ammeter readings for a complete cycle with 8-ton casting on table, running at maximum speeds, are as follows:

| | |
|---|---|
| During cutting stroke............. | 50 amperes. |
| At reversal ........................ | 70 amperes. |
| During return stroke............. | 70 amperes. |
| At reversal ........................ | 70 amperes. |

Thus it requires hardly any more power to reverse than it does to move the table during the return stroke, which means that a considerably smaller motor can be used than would otherwise be necessary. This desirable result has been obtained by making but a few slight alterations in a standard planer, the main points being the use of a proper sized fly-wheel, changing the proportions of the lower driving pulleys and the use of the lightest-weight pulleys consistent with strength. The two latter changes cause the reverse to take place quickly, smoothly and wthout any of the customary objectionable shrieking of belts. "The total work done in stopping and starting the moving parts at each reversal (this work being transformed into heat that destroys the belts) is but one-third of that which is wasted where the design is the customary one for planers of this size. Although the planer has been used chiefly on very short stroke work for the last six months, it has been found unnecessary to employ the belt tightening idlers intended for use in case the extremely hard duty should cause the belts to stretch unduly." This interesting machine is the result of extensive experiments and study of the problem made by the Crocker-Wheeler Company in the course of its investigations into the subject of motor-driven machine tools, and they are the authority for the above statement.

Fig. 5 shows a new planer, 36 ins. wide and 18 ins. high, designed specially for the heaviest class of frog and switch work by the Cincinnati Planer Company, of Cincinnati. The table, massively proportioned, is 32 ins. wide, and has an inside bearing its entire length, overcoming the pressure of the heavy side cuts, and adjustable steel gibs are provided on each side to prevent lifting. The V's are very wide and are lubricated by a series of automatic roller-oiling devices. The cross-rail has a deep box brace on the back for stiffness and is secured to the housings by a very rigid construction. The driving belts are 3½ ins. wide, the driving shafts are of large diameter, are accurately ground and have extra long bearings, and the pulleys are so constructed that they require oiling only once in 60 days. The shifting mechanism is provided with a safety locking device which prevents the table from starting, except at the will of the operator. The bull wheel and rack have 10-in. face and 2 pitch.

Recruiting Firemen.—Nearly every railroad follows the general rule of obtaining enginemen by promoting firemen who have passed through a reasonable course of training in road service prior to their promotion. This being so, the importance of employing proper material for firemen is apparent. The primary requisites in employing firemen are: a fair general education, knowledge concerning fuel consumption, the best methods of firing to result in fuel economy and the operation of the locomotive to prevent fluctuations in temperature which are detrimental to the boiler and consequently efficient operation. Satisfactory evidence should be given by firemen applying for a position of their knowledge and ability to handle fuel, prior to the approval of the application. Railroads have had to employ men on short notice and have consequently taken the material which has offered. If, however, it were well established as a general rule that each railroad required certain qualifications to be fulfilled before employment would be given, vacancies could be filled with material of a higher order, as the inducements offered are superior to those of most trades consistent with the requirements from the applicant.—*Report on Coal Consumption of Locomotives, Master Mechanics' Association*, 1904.

Mr. I. C. Hicks, general foreman of shops at San Bernardino, Cal., has been appointed master mechanic of the Atchison, Topeka & Sante Fe Coast Lines, with office at Albuquerque, N. M.

## MOTOR-DRIVEN TURRET LATHE.

The neat and compact arrangement of the headstock, the interlocking device for operating with one handle the single and double clutches which control the three runs of headstock gearing, and the arrangement of the electrical apparatus on a No. 1 motor-driven cabinet turret lathe, furnished by the American Tool and Machine Company of Boston to the Pittsburgh & Lake Erie Railroad for their McKees Rocks shops, are worthy of notice. (For illustrations see page 398.)

Referring to Fig. 1, which shows the side and end views of the headstock end of the lathe, it will be seen that the motor bracket forms a hood or casing for the headstock and that the motor controller is bolted to the door on the front of the hood, which permits access to the headstock. The controller handle is thus convenient to the operator and as the wires to the controller are carried in a flexible conduit and are attached at the left hand end near the hinges, they do not interfere with the opening or closing of the door. The Crocker-Wheeler Company 5 h.p. motor is connected to a sprocket on the main spindle by Morse silent chain.

Fig. 2 is a section through the headstock showing the arrangement of the gearing and clutches on the main spindle. The gears run loose on the spindle and mesh with corresponding gears which are keyed on the back shaft. The Morse chain sprocket is keyed to one end of the steel pinion, and the gears which run loose on the shaft are fitted with bronze bushings which have oil cellars back of them that are filled with felt and can readily be oiled by removing the oil plugs. The bevel gears at the right transmit motion to the feed mechanism.

The interlocking device and the arrangement for throwing the clutches are clearly shown in Fig. 3. When the handle D is turned down, thus turning the shaft to which it is keyed, motion is transmitted by means of the mitre gear sectors to the shaft which passes through the hood casting at the left and has a small pinion keyed to its end which meshes with the large sector and thus throws the single clutch to the position C. A little to the right of the mitre gear, on the shaft to which the handle D is keyed, is fastened a casting, so designed that when the shaft is turned and the single clutch is engaged, a small projection on it slides into a slot on the hood and thus prevents the shaft from being moved endwise. When clutch C is out the handle D can be moved either to the right or the left, thus throwing in either clutch B or A. When the long shaft is thus moved the projection on the small casting mentioned above is thrown out of line with the groove and prevents the shaft from being turned and engaging clutch C while either A or B are engaged. The arrangement is quite simple and ingenious and works easily.

Three geared feeds are provided which are operated by moving the handle just below the clutch handle and above the cabinet door either to the right or left.

Carnegie Gift to Engineering.—A circular from Prof. Hutton, secretary of the American Society of Mechanical Engineers, announces that Mr. Carnegie has prepared a deed of gift of a building to cost one and a half millions for use of the mechanical, electrical and mining engineers' organizations, and, therefore, the refusal of the American Society of Civil Engineers to join in the enterprise has no effect upon the plan. A number of architects are now preparing competitive plans for the building, and suitable progress is being made. The committee having the plans in charge hopes to report at the next annual meeting of the American Society of Mechanical Engineers, to be held in New York in December.

Light Reciprocating Parts.—Most engineers of experience know that for high-speed work the parts of an engine should be as light as possible. Thus, by employing aluminum as an experimental material for a piston in a motor car engine an increase in speed of 300 r.p.m. has been obtained, as compared with the maximum possible when a heavier piston was used.—*The Engineer*.

## LOCOMOTIVE TESTING PLANT AT ST. LOUIS.

### Schedule From Observed Data.

On page 301 of the August number the beginning of the schedule of data taken from Bulletin No. 3 was presented. This list is concluded in abstract below:

#### OBSERVED DATA.

All instruments will be read at intervals of ten minutes during the test. Observations of the more important facts will be taken by two methods, and all calculations will be carefully checked.

Item No. 196. The locomotive will be gradually brought to the required conditions of speed and drawbar pull, and after it has been running under these conditions for a sufficient time to secure uniformity in the rate of firing and to allow all parts to come to their normal working condition, the test will be started.

The heavy power tests will continue until 30 lbs. of water have been evaporated per sq. ft. of heating surface, the lighter power test being stopped at the end of four to six hours.

The duration of test, given in hours and decimals of an hour, is the elapsed time from the start as given above to the close of test.

Item No. 197. A return crank, attached to the rear pair of drivers, is connected to a rotating revolution counter, which will be read at the beginning and end of test, and every ten minutes as well. A reciprocating revolution counter is connected with the corresponding supporting axle. From the diameters of the driving wheel and supporting wheel, a factor will be obtained by which the number of revolutions shown on supporting wheel counter can be compared with the number shown by driving wheel counter.

A tachometer will also be driven by the supporting axle, and this will provide a check for the average revolutions.

Item No. 206. For the smokebox temperature a thermometer with carbon dioxide above the mercury will be used as a check on the indications of the pyrometer.

Items Nos. 207 and 212. Le Chatelier couples and a galvanometer reading to millivolts, will give the smokebox and firebox temperatures.

The couple in the smokebox will remain in position; the couple in the firebox will be inserted through an opening in the side, about midway of its length, and at a height above the bed of coal of about 12 ins. After it has been in position with the fire door closed a sufficient time to assume the temperature of the firebox, readings will be taken and the couple withdrawn from the firebox.

Item No. 210. The temperature of the steam in branch pipe will be calculated from the observed pressure of steam in same and from the observed pressure and temperature of the steam in the calorimeter connected to the branch pipe.

Item No. 211. The feed water temperature will be taken in the receiving tank.

Items Nos. 217, 218, 219 and 220. Steam pressures will be obtained by special test gages; the gage for indicating boiler pressure will be located on the steam dome on the calorimeter pipe connection, and the gage for branch pipe outside of smoke front, connected to branch pipe by as short a pipe as possible. The pressure gage located in pipe from boiler or branch pipe and leading to throttling calorimeter will be read (after the other calorimeter readings have been taken) with the valve between boiler or branch pipe and calorimeter closed on account of the drop in pressure in the pipe leading to the calorimeter while that valve is open.

Item No. 221. The barometric pressure will be measured by use of a mercurial barometer, readings being corrected for temperature, and readings in inches of mercury converted into pounds per square inch.

Items Nos. 222 and 225. The draft will be measured by "U" tube draft gages, the readings of which will be checked by recording draft gages of an approved type.

Items Nos. 228, 229 and 230. The quality of steam in dome and branch pipe will be obtained by Peabody throttling calorimeters, provided with mercurial gages reading to tenths of pounds, and thermometers reading to half degrees.

Item No. 232. All coal used will be furnished by one mine throughout the entire period of the tests, precautions being taken to have it as uniform as possible.

Items Nos. 236 and 237. Both of these quantities will be found by analysis, because the draft in a locomotive firebox is so great as to draw a part of the ashes through the flues and give incorrect data if actual weights were taken. If the ash is found by analysis the combustible must necessarily be obtained in the same manner.

Item No. 238. The smokebox front will be cleaned at the beginning of test and at close, and the quantity of cinders which have collected during the test will be weighed by an accurate scale.

Item No. 239. The stack, by which the smoke will be removed from the building, is provided with a deflector and a receptacle into which the sparks which strike the deflector will fall. This receptacle will be cleaned at commencement of test and at close, the sparks which have been collected during the test being carefully weighed.

Items Nos. 241 to 246. The analysis of the coal will be made in accordance with the method decided on by the Committee of the American Chemical Society, and given in Volume 21, No. 12, of their Journal.

Items Nos. 248 to 250. The calorific value of the coal and cinders and sparks will be determined in the Thompson calorimeter.

Items Nos. 253 to 256. The analysis of smokebox gases will be conducted by the use of the Orsat apparatus.

Item No. 259. The water used by the boiler will pass through two calibrated water meters to two steel measuring tanks holding about 1,500 lbs. of water each; and from thence to a receiving tank holding about 17,000 lbs. of water.

The measuring tanks rest on calibrated platform scales, so that their capacities can be calibrated at frequent intervals, correction being made for temperature.

To obtain the total water delivered to injectors, the number of times each tank is emptied will be multiplied by their calibrated capacities at the average temperature of water during the test, and the fractional part of tank weighed out at close, added.

At the beginning of test the level of water in the boiler and receiving tank will be noted; the levels of water in both will be kept slightly below these levels during the test. At the close sufficient water will be fed into the receiving tank to restore the initial level. The level in the boiler will be noted, and when not the same as at the start, a correction will be made.

The quantities found by the measuring tanks are checked by two meters. Provision being made to catch and measure the small amount of water wasted in filling the tanks, the meter readings less this waste will be a check on the quantity delivered by the measuring tanks.

Items Nos. 260 and 263. The water which escapes from the injector overflow pipes will be caught and returned to receiving tank; and no credit will be given the boiler for the rise in temperature, if any, of this water.

Great care will be taken to prevent leakage from the boiler; the air pump and steam heat throttles will be disconnected so that leakage may be detected and the throttles made tight.

Leakage tests, when necessary, will be made on boiler after close of test, due allowance being made for change of temperature of water.

Item No. 265. The pull exerted by the locomotive will be measured by a traction dynamometer, already described in Bulletin No. 2.

The pen on the dynamometer will give a continuous record of the drawbar pull, which will be measured at ten-minute intervals; the average of these measurements to the scale of springs used will will give the average drawbar pull.

An integrating attachment records the square inches of the area included between the line of zero pull, or the base line, and the line of drawbar pull; this area, divided by the length of diagram, will give the average height and provides a check for the mean height obtained in the method first described.

Items Nos. 266 and 267. The maximum and minimum drawbar pull will be found by measuring the diagram after the test, or will be registered by an automatic attachment.

Items Nos. 268 to 291. The percentages of stroke, at which cut-off, release, and beginning of compression take place, will be determined by locating on each card the points at which these events occur. This will be done by the same method throughout the entire series of tests.

The length of each indicator card will be measured and an average obtained for cards for each end of each cylinder; the length of stroke up to the time cut-off takes place will be measured and averaged in a similar manner. The percentage that this average length of cut-off forms of the average length of card, will be the result on the data sheet. The percentage of stroke at which the other events mentioned take place will be calculated in a similar manner.

Items Nos. 292 to 299 and 306 to 329. The points showing the events of the stroke on indicator card at which pressures are measured, are described in the preceding paragraph, with the exception of the point representing the initial pressure, which also will be measured.

The pressures of steam corresponding with the several events of stroke in cylinder, as shown by the indicator card, will be measured by appropriate scale, and the results for each end of each cylinder averaged for each event. The average thus obtained will be corrected for the error of the spring under the conditions and pressure, *i. e.*, whether under increasing or decreasing pressure.

Items Nos. 301 to 304. Indicator cards will be taken from indicator on steam chest, the pressure given is the average pressure of these cards.

Items Nos. 330 to 337. The least back pressure will be measured in the same way as the pressures under Items Nos. 292 to 299, and the results averaged.

The exact location on the card of the point of least back pressure will vary somewhat on different cards of the same test, but the least back pressure will be taken without regard to exact location.

SUMMARY OF AVERAGE RESULTS.

*Boiler.*

Items Nos. 340 and 341. The "moist steam per hour," Item No. 340, is the average water evaporated by boiler per hour uncorrected for moisture in steam, while "dry steam per hour," Item No. 341, is corrected for moisture by multiplying No. 340 by the "factor (F) of correction for quality of steam."

Item No. 346. The equivalent evaporation from and at 212 deg., per lb. of coal as fired, is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of coal as fired, Item No. 233 ÷ Item No. 196.

Item No. 347. The equivalent evaporation from and at 212 deg. per pound of dry coal, is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of dry coal, Item No. 338.

Item No. 348. The equivalent evaporation per pound of combustible is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of combustible, Item No. 236 ÷ Item No. 196.

Item No. 349. The boiler horse-power will be found by dividing the equivalent evaporation per hour, No. 344 by 34.5.

Item No. 350. The efficiency of the boiler is found by multiplying the equivalent evaporation per pound of dry coal, No. 347, by 965.8, and dividing the product by No. 248, the number of thermal units in one pound of dry coal.

No credit is given the boiler for heat units used in evaporating moisture contained in fuel as fired.

*Engines.*

Items Nos. 351 to 358. All indicator cards will be integrated twice by different computers.

After the average mean effective pressure of the indicator cards for each end of each cylinder has been ascertained, the card most nearly approximating the average will be selected to represent the test. In case these cards are subject to correction, resulting from a calibration of the indicator spring, the following method will be used:

Vertical lines dividing the length of card into ten or twelve equal parts will be drawn. At the points where these lines intersect the lines of the card, the card will be corrected (correction curves having been made for each spring); if an increasing pressure, for the error of the spring under similar conditions, if descending, in like manner. A new card will be drawn through the points thus located and the relation of the area of the rectified to the actual card will give a factor which will be used in finding the corrected M. E. P.

Items Nos. 365 to 372. The indicated horse-power is found by multiplying together the I. H. P. constant, the average revolutions per minute and the mean effective pressure.

For the head end of right high pressure cylinder, the indicated horse-power = No. 180 × No. 198 × No. 351.

The formula for the other items will be similar in form, with the corresponding quantities substituted.

Item No. 381. The dry steam per indicated horse-power per hour is found by dividing the dry steam per hour, Item No. 341, less the steam used by calorimeters or other instruments, by the total indicated horse-power, Item No. 379.

Item No. 382. The B. T. U. per I. H.-P. per hour is found by multiplying the dry coal per I. H.-P. per hour, Item No. 380, by the calorific power of one pound of dry coal, Item No. 248.

*Locomotive.*

Item No. 383. The dynamometer horse-power is found by multiplying together the D. H.-P. constant, Item No. 179, the average revolutions per minute, Item No. 198, and the average draw-bar pull, Item No. 265, or D. H.-P. = No. 179 × No. 198 × No. 265.

Items Nos. 384 to 386. The pounds of coal, steam and B. T. U. per D. H.-P. hour are found in the same manner as the corresponding items for indicated horse-power hour.

Items No. 387 to 389. The number of foot-pounds is found by multiplying together the average drawbar pull, Item No. 265, the average circumference of the driving wheels in feet, Item No. 13, and the total revolutions, Item No. 197.

Item No. 395. The machine friction of locomotive in terms of horse-power, is the difference between the average indicated horse-power and the average dynamometer horse-power. This does not take into account the friction due to engine truck and trailing wheels and axles.

Item No. 396. The machine friction in terms of pounds mean effective pressure, for simple engines, will be taken as the machine friction in horse-power (No. 395), divided by the average horse-power constant and the average revolutions per minute.

Item No. 397. The machine friction in terms of pounds drawbar pull is the frictional horse-power, No. 395, multiplied by 33,000 to convert it into foot-pounds, divided by the distance in feet per minute.

Item No. 398. The machine efficiency of locomotive in per cent. will be taken as 100 times the ratio of the D. H.-P., No. 383, to the I. H.-P., No. 379.

Item No. 399. Efficiency of locomotive will be found by dividing the heat equivalent of one horse-power for one hour by the B. T. U. per dynamometer horse-power hour, No. 386, shown by test. This quantity multiplied by 100 will be the efficiency in per cent.

*Coal Calorimeter.*

The calorimeter to be used is the William Thompson calorimeter with some slight modifications to facilitate working and output. This calorimeter has been standardized by testing in it two samples of coal which were previously tested in ten different bomb calorimeters, including a test in the bomb calorimeter at the Bureau of Standards, Washington, D. C. The mean of these ten determinations is taken as representing the heat units in these two coals, and these coals when tested in the Thompson calorimeter, enable it to be standardized so as to give results the same as the bomb calorimeter. Furthermore, a sufficient amount of these two coals has been prepared so that the Thompson calorimeter can be frequently checked. It also provides a means of ready standardization, in case of accident to any of the parts of the Thompson calorimeter, or in case of getting a new instrument complete.

*Orsat Apparatus for Anaylsis of Smokestack Gases.*

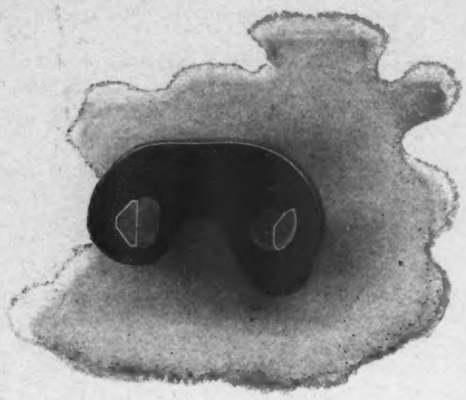
The Orsat apparatus to be used in analysizing the smokebox gases has had its measuring pipette carefully calibrated by filling with water at room temperature, and then weighing this water as a whole and in successive portions corresponding to the graduations on the measuring pipette. The necessary corrections, where any were found requisite, will be used in reading the percentages from the measuring pipette.

## MORSE SILENT CHAIN.

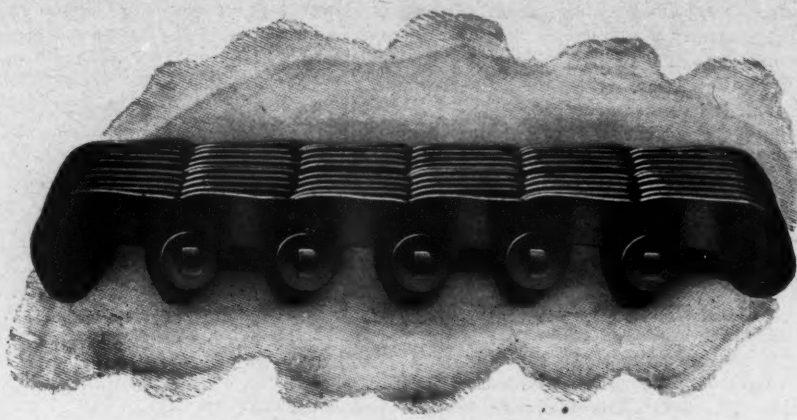
To the engineer who is confronted with the problem of applying individual motors to either old or new machine tools, or who is looking for a compact and efficient means of transmitting power, this chain is invaluable. It is much more efficient than belting, and where the size of pulleys is limited or it is necessary or desirable to use a short distance between centers or to transmit a large amount of power it can be used where belting cannot be. Because of its noiseless action and the positive and large speed ratios which can be obtained it can often be used to good advantage in place of gearing. Those who have watched the progress of motor-driven machine tools or who have followed the series of articles which have appeared in this paper on the application of individual motors to the old machine tools at the McKees Rocks shops, will recognize its value for such work.

It can be run up to speeds of 2,000 ft. per minute, can run on sprockets with as few as 13 and as many as 130 teeth, has a sustained efficiency of nearly 99 per cent, is silent running, can be used in the presence of moisture, heat or dust, and does not wear the joint or lengthen from the lack of lubrication.

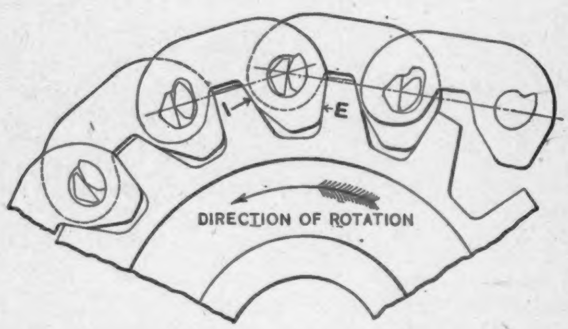
Its construction is clearly shown on the accompanying illustrations. The joint consists of two pieces of hardened tool steel, so shaped and arranged that, as the joint works while passing on and off the sprockets, one piece rocks or rolls on the other. Each part of the joint is fixed in opposite ends of the links, and as there is only a pure rolling friction on hardened tool steel surfaces with ample contact area to stand the pressure, there is no tendency for the joint to wear and cause the chain to lengthen. To prevent undue vibration under high speeds and the consequent wear, the rocker pins of the high-speed, silent-running chain are so shaped that the contact surfaces are greatly increased when the chain is drawn straight



LINK SHOWING HOW PINS FIT.

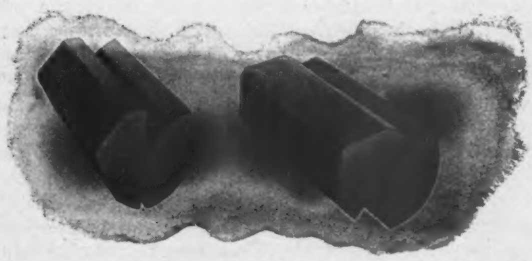


EXTERIOR APPEARANCE OF CHAIN.

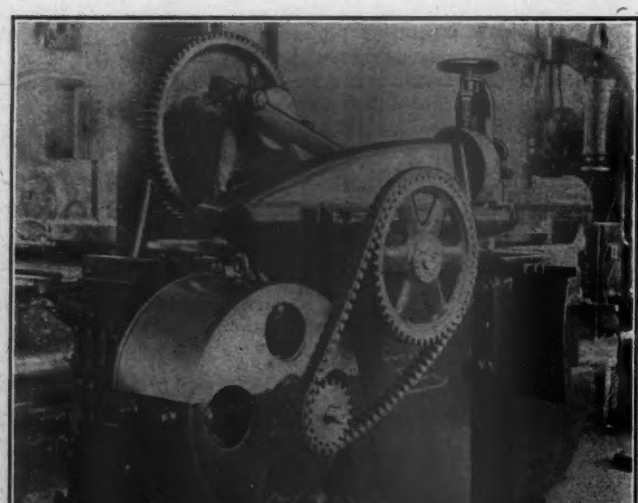



SHOWING ACTION OF CHAIN ON SPROCKETS.

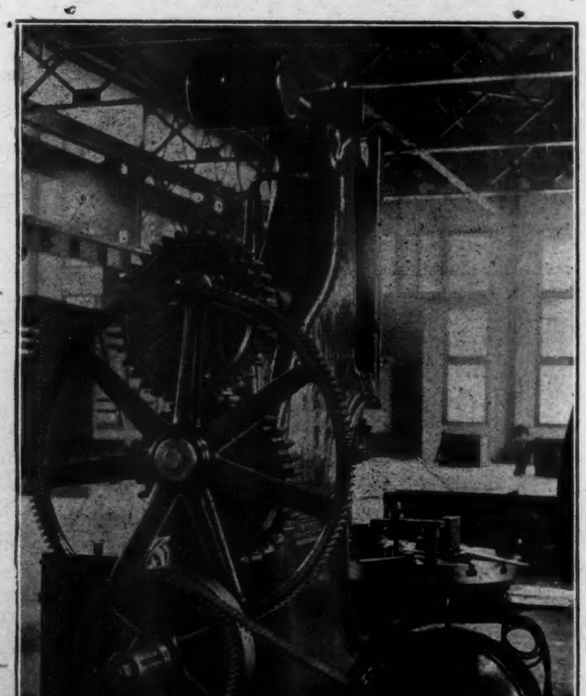
TWO 50 H.P. MAIN SHAFT DRIVES ON 48-IN. CENTERS SHOWN IN MOTION.—TWO CHAINS FROM EACH MOTOR, RUNNING AT 1,445 FT. PER MINUTE.



ACTION OF ROCKER PINS ON STRAIGHT PULL AND ON SPROCKET.



APPLICATION TO 12-IN. HEWES & PHILLIPS SHAPER.



APPLICATION TO 19-IN. PUTNAM SLOTTER.

MORSE SILENT CHAIN AND APPLICATIONS.

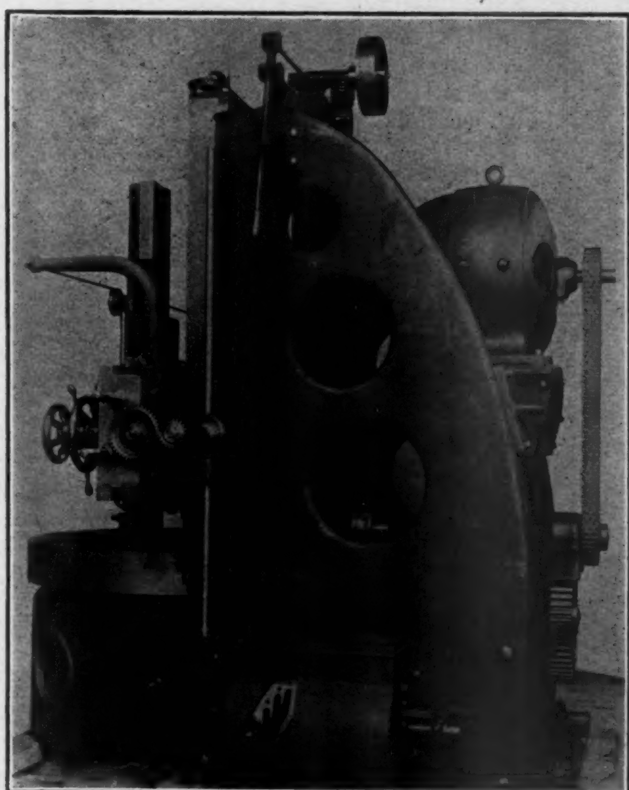
between sprockets, giving a broad bearing in this position. The two-part pin used in the Morse rocker joint permits of an unbroken contact the whole width of the chain, less the outside links, thus nearly doubling the length of the bearing surface over a chain with a single-pin joint.

As the rocker joint is subjected only to rolling friction it does not require lubrication, and the speed limit is therefore not fixed by the point at which the centrifugal force will throw off the lubricant. On the small line cut showing the action of the chain on the sprocket the link engages the tooth at E on the driving sprocket and at I on the driven sprocket. The chain will run in either direction. A paste grease, sufficiently heavy so that it will not be thrown off at high speeds, affords proper lubrication for the chain in its contact with the sprocket teeth and between the plates of the chain itself. As the pressure between the chain and the sprocket teeth is inversely proportional to the number of teeth in contact with the chain, and as this number is large, the pressure is small, and very little wear will take place. The life of a silent-chain is proportional to the number of teeth in the large sprocket, and since the lengthening of the Morse chain is very slight it is possible to use very large sprockets and make large speed reductions. The relation of the size of the wheel to the life of the chain—and this is the principal feature that makes it silent—comes from the fact that the chain climbs higher on the tooth as it lengthens and does not become inoperative until the top of the tooth is reached. The height of the tooth for a given pitch is practically the same for all sized wheels, and it follows that in a unit length of chain, equal to the circumference of any wheel, the total lengthening that may take place before the top of the tooth is reached is the circumference of a circle whose radius is the height of the tooth. The amount of stretch, therefore, that can take place per link in this unit of length of chain is inversely proportional to the number of teeth in the wheel, which equals the number of links in the chain. It is for this reason that with a chain having the less lengthening due to joint wear the greater the number of teeth that can be satisfactorily used in the large wheel, with a consequent larger speed ratio.

The sprocket wheels are made of high grade cast iron, accurately cut, and in use show little or no wear. For exceptionally hard service or when there is little metal around the shaft, hardened steel sprockets are furnished. To properly guide the chain, special guiding links are used, projecting below the balance of the chain into grooves turned in the sprockets. The holes in the opposite ends of the links are punched to conform in shape to and securely hold, in the large end of the link the rocker pin, and in the small end the seat pin, there being no motion between either part of the joint pin and link. The outside links are bent laterally so that the large end comes under the small end of the adjoining link to permit of the proper engagement with both seat and rocker pin. The joint pins are made of the best grade of tool steel carefully hardened, the shouldered ends of the seat pins being softened to permit of being riveted in the outside links or in washers in the larger pitches to securely hold the chain together.

This chain has a wide range of applications, from heavy main drives direct from engine or motor on short centers, to light drives on machine tools. A few interesting applications are shown on the accompanying illustrations. The chain is made by the Morse Chain Company, Trumansburg, N. Y.

7-H. P. AIR COMPRESSOR.



BAUSH 51-IN. BORING MILL.

CUT-OFF SAW.

MORSE CHAIN APPLICATIONS.

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More steam (about 250 b. h. p.) can leak out through a 1-in. hole in a steam pipe at 150 lbs. steam pressure than one fireman would usually supply by steady coaling. Leaks in steam pipes are apparently insignificant, but they rapidly dissipate the heat generated in the consumption of a large amount of coal. Uncovered steam pipes also waste large amounts of coal. Approximately about 1-3 of a lb. of steam would be condensed by each square foot of naked steam pipe per hour, which would mean that 1 b. h. p. is dissipated by every 90 sq. ft. of naked steam pipe.—*Prof. R. C. Carpenter in Power and Transmission.*

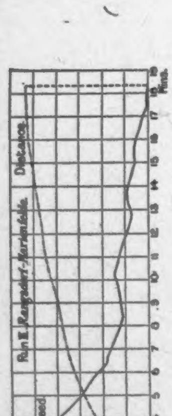


FIG. 1—CURVES SHOWING RETARDATION OF CAR "A."

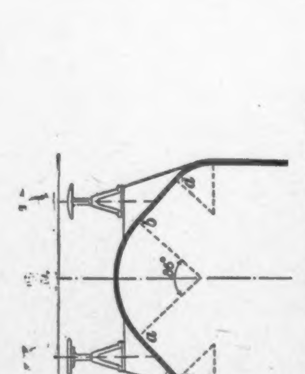


FIG. 3—SHAPE OF FRONT OF CAR.

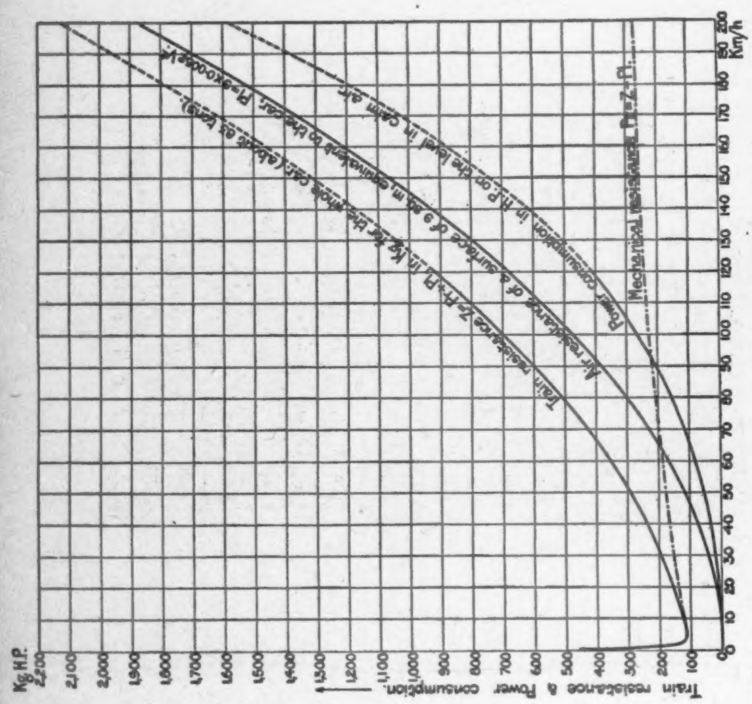


FIG. 2—TRAIN RESISTANCE AND POWER CONSUMPTION OF HIGH-SPEED CARS.

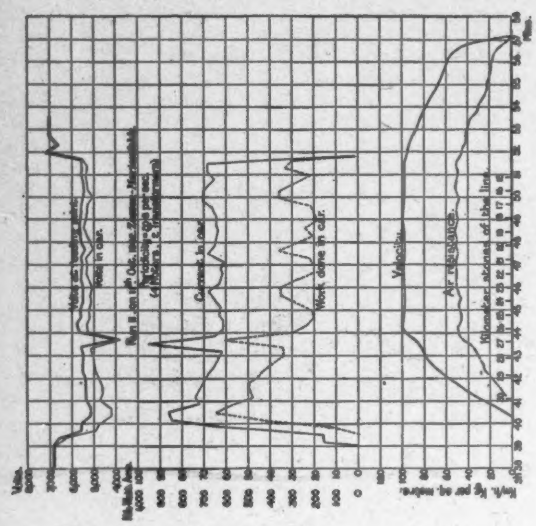


FIG. 4—RUNS WITH CAR "A."
*Weight* = 89,500 *Kg.*

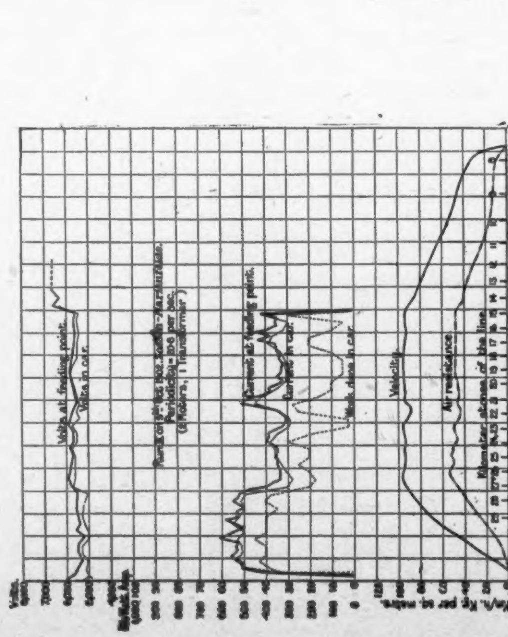


FIG. 5—RUNS WITH CAR "S."
*Weight* = 77,900 *Kg.*

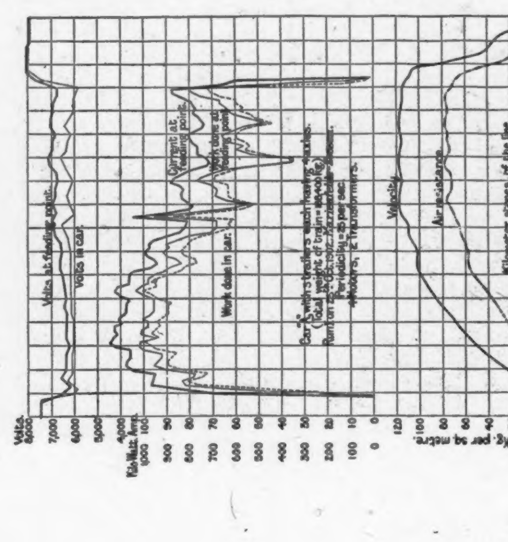


FIG. 6—RUNS WITH TRAILERS.

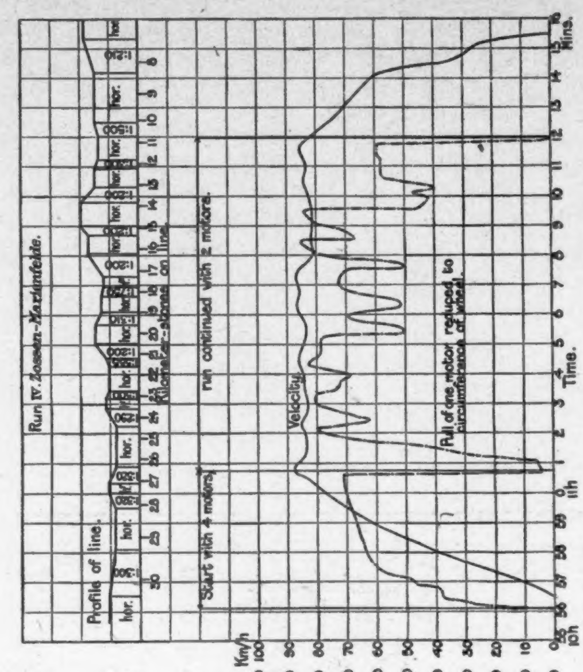


FIG. 7.—TRIAL RUNS WITH CAR "A."

HIGH SPEED RECORDS ON MARIENFELD-ZOSSEN EXPERIMENTAL LINE.

## HIGH SPEED EXPERIMENTS.

MARIENFELD-ZOSSEN ELECTRIC LINE.

An elaborate paper by Mr. Alexander Siemens before the Institute of Electrical Engineers (London) presents valuable records and statements concerning the result of these trials. The paper is too long to reprint. It recites the history of the groups of experiments and presents purposes and methods and describes the equipment and apparatus. The following paragraphs constitute an attempt to describe the most important features of the paper.

There was no serious difficulty with conducting and transmitting high tension current to the cars and motors. This portion of the problem is considered solved. The permanent way, however, was not satisfactory at the highest speeds, due to the great weight of the cars. The cars were too heavy for economical operation and the experiments show the necessity for using stationary transformers and otherwise lightening the electrical machinery, also for using very high voltages without transformers.

Two cars are referred to in the paper, one having been equipped by the Allgemeine, Elektrizitats-Gesellschaft and designated car "A." The other was equipped by Messrs. Siemens & Halske and designated car "S." Most careful, elaborate and complete data were taken as to speeds, power, air resistance and acceleration. Regular runs of both cars began October 14, 1901. In the third series of experiments car "S" reached a speed of 160.2 km. per hour on November 5. The track was severely punished and the speeds were afterwards restricted to 130 km. per hour.

To attain a speed of 100 km. per hour required a distance of from 2,000 to 3,200 meters and from 138 to 220 seconds, giving an average acceleration of 0.13 to 0.2 m. per second, and requiring from 700 to 1,000 h.p. With a motor capacity of 3,000 h.p. more rapid acceleration might have been attained except for the deficiencies of power at the generating station. The experimenters found the braking question more important than acceleration, because it concerns the safety of the train. The braking trials, however, were not considered as conclusive. Both cars had Westinghouse quick-acting brakes, hand brakes and electric brakes acting by reversal of the current through the motors. The "A" car had in addition an accumulator battery, the current of which would be put through the three-phase motors. In Fig. 1 is shown a curve of speed from car "A" when allowed to drift from a speed of 160 km. per hour.

Observations of power required at constant speed are given in the following table:

POWER REQUIRED AT CONSTANT SPEED.

| | | B. H. P. | | | Efficiency of electrical outfit. | | Consumption. of steam. Kg. per B. H. P. per hour. | |
|---|---|---|---|---|---|---|---|---|
| Car. | Speed, Km. per hour. | Measured at feeding point. | Measured at car collector. | Calculated from speed. | Car by itself. Per cent. | Car and conductors. Per cent. | At car wheels. | At flywheel of steam engine. |
| "A" ...... | 118 | 478 | 455 | 397 | 87 | 83 | 5.84 | 4.6 |
| "S" ...... | 115.. | 431 | 405 | 341 | 84 | 79 | 6.12 | |

Air resistance was most carefully studied by means of air tubes and water gauges. By a process of exploration it was found that a cone of uniform pressure exists in front and at the back of the car the apex of which was about 3 m. from the car. It will be necessary to wait for further experiments to obtain a definite formula for the air resistance. Fig. 2 records the traction resistance of a car weighing 83 tons, the air resistance of a surface of 9 sq. m. and the horse-power required on a level with no wind. From these curves the mechanical friction may be obtained by subtraction. These curves show how important air resistance becomes at high speeds. Fig. 3 illustrates the form determined upon for the car fronts.

Figs. 4, 5 and 6 give data as to power required with and without trailers. Turning moments were measured directly from the motors, and the results of a run made November 8 on car "A" are given in Fig. 7.

The experiment to show the possibility of using motors with high tension currents are considered to have demonstrated the feasibility of employing three-phase currents of 10,000 volts without transformers.

The complete paper must be consulted by readers who desire to study the results in detail.

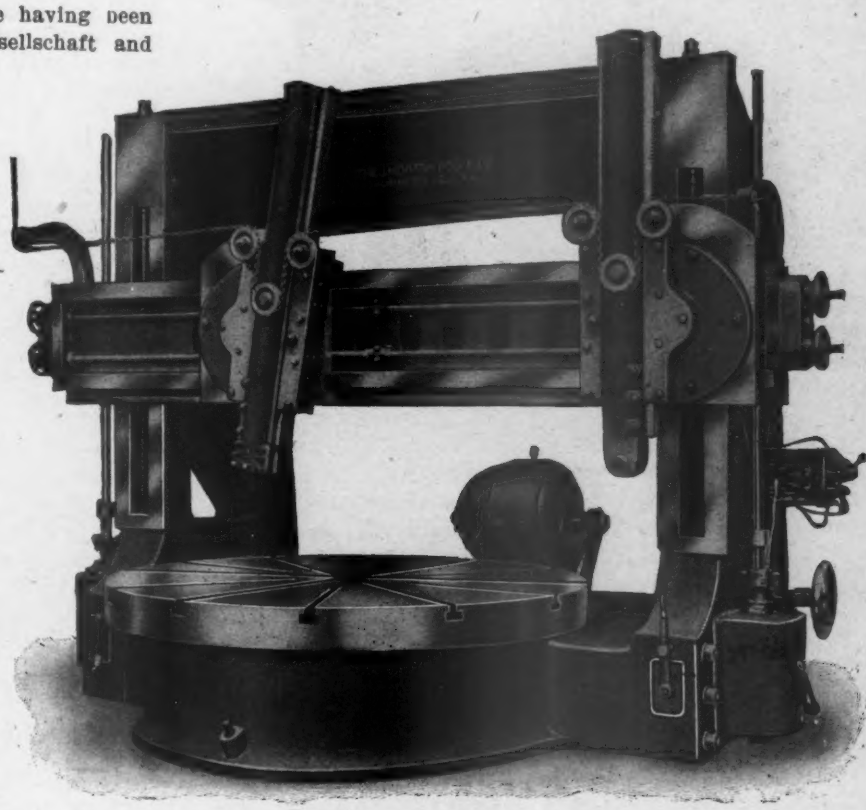


FIG. 62.—10-FT. BORING MILL.—J. MORTON POOLE COMPANY.

## MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

XV.

A powerful driving mechanism arranged to furnish several different table speeds, and a geared variable-speed feeding mechanism are features of the boring mills made by the J. Morton Poole Company, of Wilmington, Del. These machines are designed for the use of high-speed tool steels, and can be arranged for either a motor or a belt drive.

Fig. 62 shows one of their 10-ft. motor-driven boring mills. The table rests upon a wide flat annular bearing near its outer edge which is automatically lubricated by rollers located in pockets and held against the bearing by springs. It is driven by a powerful "Hindley" worm wheel which is mounted on the spindle between the upper and lower bearing and runs in an

oil chamber. Placing the worm wheel on the spindle in this way enables the operator to elevate the table from its outer bearings and take the thrust on the spindle step bearing without destroying the alignment of the worm and wheel.

Fig. 63 shows the arrangement of the worm gearing and

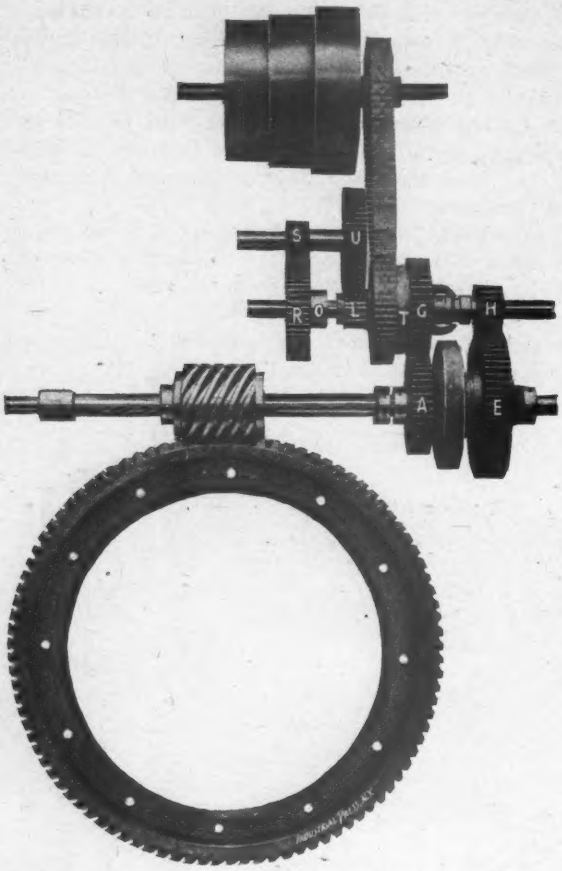



FIG. 63.—DRIVING MECHANISM.

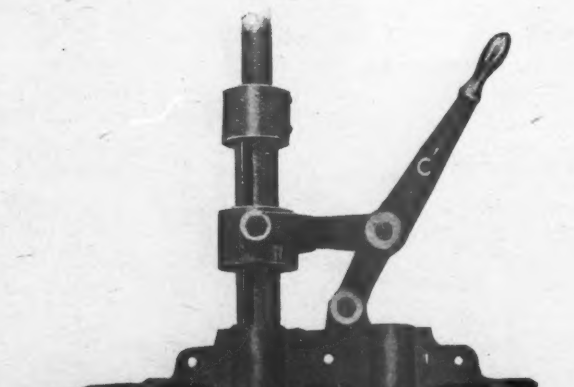
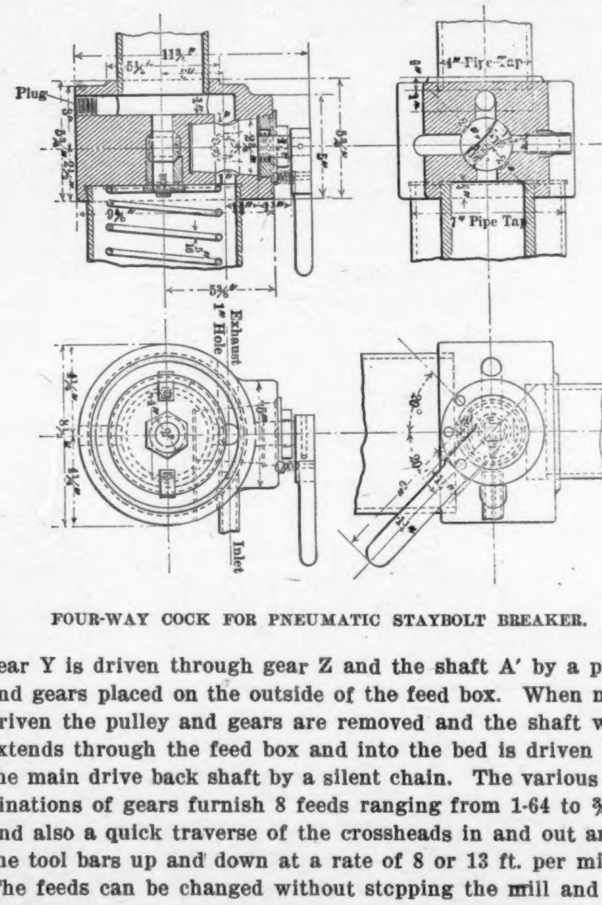



FIG. 64.—FEED GEARS.

driving mechanism. With a motor drive the speed cone is replaced by a motor. Gears G and H are keyed to the back gear shaft and drive the loose friction gears A and E. The chain sprocket T runs loose on the back gear shaft and carries the pinion L, which drives the back gears U, S and R, the latter running loose on the shaft. The chain sprocket can drive the back gear shaft direct, by operating the friction clutch between G and T, or a back gear ratio of 8 to 1 can be obtained by engaging the clutch O, which is keyed to the shaft with the hub of gear R. This arrangement of gearing furnishes four speeds with back gear ratios of 12, 36, 95 and 285 to 1. If the machine is belt driven and a three-step cone pulley and a two-speed friction countershaft are used, 24 table speeds are available and either series of eight speeds can be obtained without shifting the belt or stopping the machine. Speed changes are made by means of the hand wheel and a lever at the right side of the machine.

The feed box with the cap removed is shown in Fig. 64. On each end of the main worm shaft is a feed worm, B, driving the worm wheel C, which is keyed to the pinion D running loose on the shaft. Gear F is also loose on the shaft and is driven from D through gears I and J which run loose on the other shaft and give a feed back gear of 8 to 1. Either D or F can be engaged with the shaft by means of a sliding key operated by the lever B'. Gears K, M, N and P are keyed to the shaft and drive the four loose gears Q, V, W and X, any one of which or the rapid traversing spiral gear Y can be engaged with the shaft by the lever C', which operates a sliding key on the shaft. If the machine is operated by a belt-drive, spiral




FOUR-WAY COCK FOR PNEUMATIC STAYBOLT BREAKER.

gear Y is driven through gear Z and the shaft A' by a pulley and gears placed on the outside of the feed box. When motor driven the pulley and gears are removed and the shaft which extends through the feed box and into the bed is driven from the main drive back shaft by a silent chain. The various combinations of gears furnish 8 feeds ranging from 1-64 to ¾ in., and also a quick traverse of the crossheads in and out and of the tool bars up and down at a rate of 8 or 13 ft. per minute. The feeds can be changed without stopping the mill and it is impossible to throw the traverse and power feeds in at the same time. The feeds and the traverse of the crossheads are controlled by the two hand wheels on the gear boxes at each end of the crossrail. The two heads are entirely independent.

A lever in front of the right hand upright controls a friction clutch for elevating and lowering the crossrail which travels at a rate of 4 to 7 ft. per minute.

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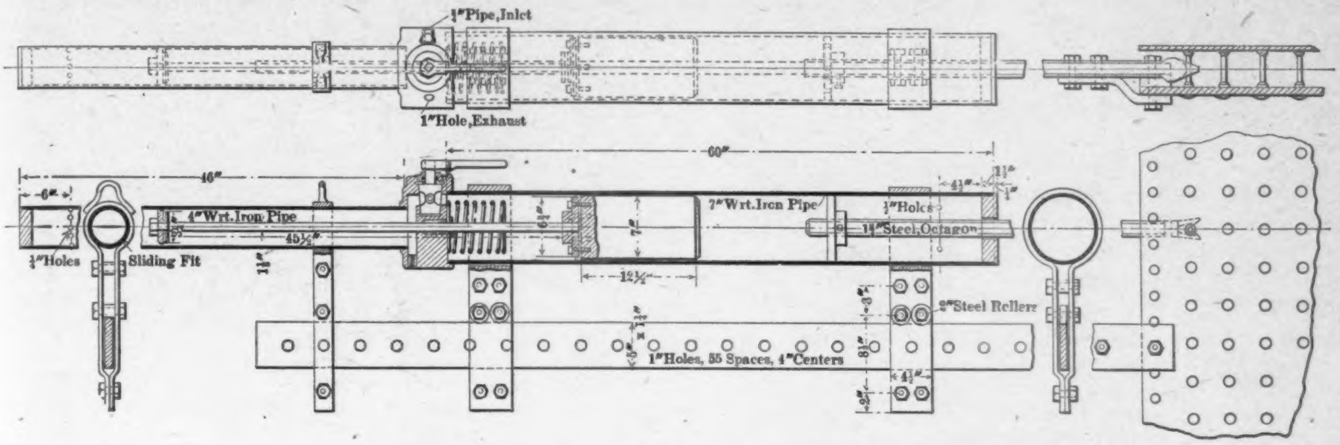
While we need about 10 2-3 lbs. of air per pound of combustible carbon and should have, to insure safety, probably 15 lbs., we usually find 25 to 30 lbs. have passed through our furnace. The economic result of this large supply is to increase the amount of heat wasted in the chimney from a minimum of 8 to 12 per cent. to an amount averaging frequently 25 to 30 per cent. The wastes due to an excessive supply of air can be largely reduced by good firing and by use of proper appliances. —*Prof. R. C. Carpenter in Power and Transmission.*

## PNEUMATIC STAYBOLT BREAKER.

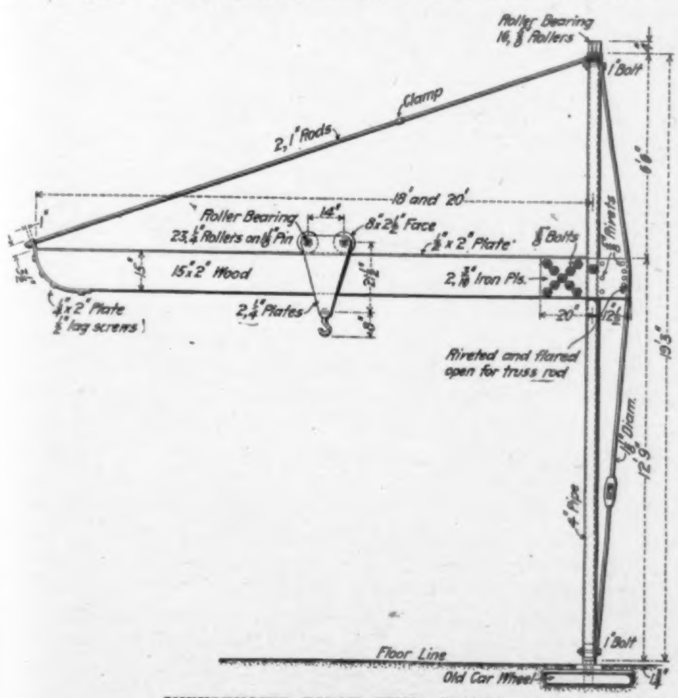
CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

At the Moline shops of the Chicago, Rock Island & Pacific Railway a pneumatic staybolt breaker is in very satisfactory use. It breaks one and often two or three staybolts with one blow. This device can be easily constructed by any tool room force, and it offers marked advantage over the usual sledge-and-laborers method.




PNEUMATIC STAYBOLT BREAKER.—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

A heavy, single-action plunger 7 ins. in diameter strikes the 1¾-in. octagon steel cutter bar, which is placed against the staybolt. A 4-in. pipe constitutes the return, or pull-back, cylinder, the control being by means of a 4-way cock, the casting of which forms the connection between the two cylinders. The cylinders rest upon rollers on a 5-in. by 1¼-in. bar, the right hand end of which is secured to the firebox. This bar has 55 1-in. holes at 4-in. centres, and a pin is passed through it at the proper location for a resistance to the cylinder against the blow of the ram. The engravings show a longitudinal section and plan and details of the 4-way cock.




INEXPENSIVE FORGE SHOP CRANE.

## AN INEXPENSIVE FORGE SHOP CRANE.

In view of the fact that a crane such as the one shown in this engraving may be made from scrap material which is to be found in any railroad shop plant, there is no excuse for the absence of such conveniences in either forge or machine shops. The sketch speaks for itself. The crane costs nothing and will carry a load of 1,500 lbs. It is used at the Atlanta shops of the Southern Railway, the drawing having been furnished by Mr. S. S. Riegel, chief draftsman. These cranes are supplied with both air and chain hoists.

## THE WESTINGHOUSE AUTOMATIC AIR AND STEAM COUPLER.

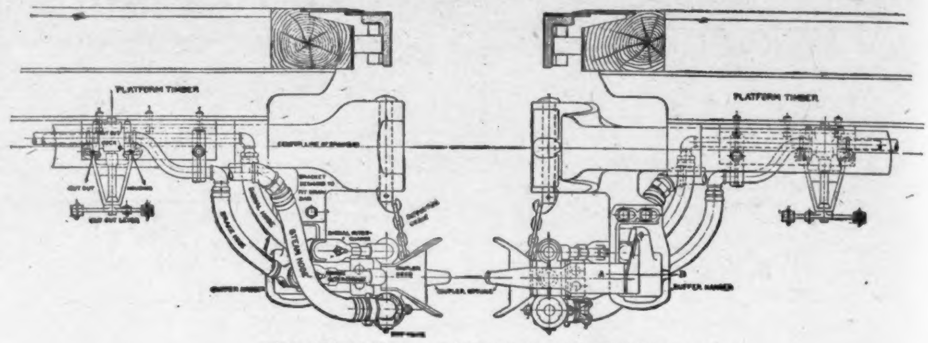
The objects in view of a device to do away with the common method of hand clamping of inter-car hose connections were threefold. The question of the safety of the railroad employe was regarded as of first importance. Despite the adoption of the automatic car coupler, railroad employes engaged in making up and distributing trains were still exposed to a very serious danger in this hose coupling, the platforms, safety chains and hand brake rods impeding escape from between the vestibuled cars of passenger trains in case of a premature starting signal to the engineer, and the great length of freight trains, with only a few men to attend to coupling and confusion of authority in starting, making freight hand hose coupling especially dangerous work. Instances of scalding as a result of the unexpected uncoupling of a hand steam connection while being tightened were not infrequent, and inconveniences in handling hot steam connections were a still further element of danger and delay. These features of hand coupling were not without their bearing on the financial reports of the big railroad companies. It is self evident that automatic hose couplings which have withstood the severest durability tests entirely eliminate all elements of danger. The Westinghouse device, placed in a special machine arranged to couple and uncouple a set twenty-six times a minute for ten hours a day, showed the first signs of weakening only after 64,000 couplings—an equivalent of about twenty years' actual service—had been effected.

Time economy was the second and no less important object in view, and the records of several years' operation on a number of the best known American railroads indicate that the opportunities for improvement of schedule by the completion of the equipment of automatic coupling had not been underestimated. The Long Island Railroad, which has equipped its entire passenger rolling stock, 565 cars and 170 locomotives, with the modern device, has found that congestion at terminal stations has easily been avoided since its adoption. The New York Central Railroad, which operates its entire Putnam Division, consisting of 84 cars, with this automatic hose coupling, has found a great saving of time in making up trains. The Missouri Pacific, which has adopted the automatic coupling for its entire suburban service out of St. Louis, after very complete trial, has found it to be a factor of considerable value in the maintenance of a heavy short haul schedule. The Texas Midland, which has equipped its entire passenger service with it, the Pennsylvania, which has used it on the Middle Division

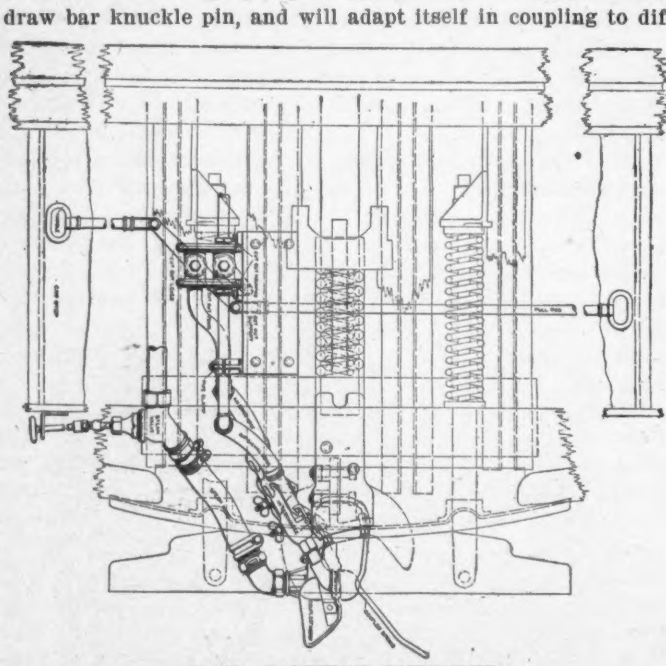
between Harrisburg and Altoona, the Boston & Maine and the Queen & Crescent roads report equally satisfactory results.

The New York Central Railroad has estimated that the cost of hose under the old method was 230 per cent. of that under the new. It has been estimated, after careful compilation of reports as to the length of service of hose removed from the cars on one big railroad system during 1903, that the average life of hose, when uninjured by accident or careless treatment, was about 35 months for the best grades and from 20 to 25 months for the cheaper grades. The monthly inspection reports of the same road, however, showed that only 60 per cent. of the hose removed had become porous, as an indication that it had run its full service, the other 40 per cent. having been burned, cut, chafed, or strained or torn at the nipple, as a result of carelessness in coupling or uncoupling or in permitting the hose to dangle along the tracks, or as a result of exigencies or service or accidents in which cars were pulled apart before the hand hose connections had been uncoupled. The Westinghouse automatic hose couplings, which will operate perfectly on a 20-degree curve with 4-in. variation in the height of cars, give positive assurance that the couplings are at all times perfectly made, without the slightest friction or pull on the hose connections, and are at the same time so constructed that the uncoupling, which is always automatic, will positively be effected without strain of any kind on the apparatus, should the train be parted by accident, the air brakes being thus automatically applied.

The Westinghouse automatic hose couplings, as exhibited at the St. Louis Fair, are interchangeable, with no rights or lefts. The coupling head, which is of malleable iron having V and wedge shaped guides projecting toward the front and an outwardly bent spring firmly riveted to the back, is supported by the coupling spring resting in the slotted buffer hanger, the hanger being bolted to a cast steel bracket riveted to the drawbar. It is held in proper position by a chain attached to the draw bar knuckle pin, and will adapt itself in coupling to differences in height of cars or angles of contact which would not permit the operation of the automatic car coupler itself. The slotted buffer hanger consists of a malleable iron frame embodying a spring seat and a cup shaped buffing piece pivoted from the upper part of the hanger, a volute spring holding the buffing piece forward to furnish a yielding resistance for the head during the coupling, the car coupler itself checking the impact before the buffer spring of the automatic hose coupling has been fully compressed. The coupling heads, which are alike for passenger and freight service except in the number of gasket openings in the face, are so modeled that the positive engagement of the connections is effected without friction or wear on the gaskets, the gaskets being placed in holes in the coupling face connected to the pipe terminals by short hose. In designing the automatic hose coupling the importance of an interchange arrangement by which it could be adapted for use in connection with the old hand couplings was not overlooked, and proper provision has been made for accomplishing this purpose in a number of different ways, the difference being in the fittings of the lower end of the hose from the pipe terminals and in the attachments to the coupling face. Interchange with cars equipped with hand couplings is effected in little more than the time necessary for the usual hand couplings under the old method. The accompanying engravings illustrate the passenger equipment coupler, the freight device being somewhat simpler.



SIDE ELEVATION.—PASSENGER EQUIPMENT.


PLAN.—PASSENGER EQUIPMENT.

## NEW WORKS OF WEIR FROG COMPANY.

The Weir Frog Company, of Cincinnati, have completed their new works in Norwood, a suburb of Cincinnati, and located on the Baltimore & Ohio, the Pennsylvania Lines and the tracks of the Cincinnati Traction Company, thus having exceptionally good shipping facilities. The plant was designed by Bert Baldwin & Company, architects and engineers.

The plant consists of a main shop and two smaller buildings, interior views of which are shown in engraving. The main shop is 622 ft. long by 125 ft. wide, and gives 83,000 sq. ft. of floor area in a single story building. It has a main aisle 61 ft. 2 ins. wide and two 31-ft. bays. Steel roof trusses on steel columns support the roof. Natural lighting is provided by side windows set about 6 ft. above the floor and by four skylights in the roof itself, in addition to the side windows in the main roof. Heating apparatus was furnished by the American Blower Company and the Webster vacuum system, using exhaust steam from the shop engines. The erecting and main machine floors are of concrete and cement, occupying 260 ft. by 125 ft., situated just beyond the tool room and template storage room, which are first entered after leaving the office building. The 60-ft. span is served by two Case Manufacturing Company electric cranes, one used chiefly to unload cars and the other to handle material from the stock department. On this floor are the planers, straightening machines and special machinery. Beyond the erecting floor is the stock department, where all material taken into the shop is stored. This end of the building is entered by a track holding 10 cars and depressed to unload material directly upon the shop floor. This department is 60 ft. by 400 ft., and is enclosed by a fence. All heavy material, such as rails, plates and bars, is piled on the floor; small supplies, such as rivets, bolts and nuts, being kept in bins. On the south side of the main building is the forge department, equipped with forging machines, presses, hammers, heating furnaces and smith fires. Opposite the forge department, on the north side, are located special tools for bending, curving and drilling rails.

The power plant consists of a 500 h.p. Brown automatic compound engine, built by I. & E. Greenwald Co., Cincinnati, direct connected to a 300-kw. Bullock 220-volt generator. Except a


INTERIOR VIEWS OF THE NEW WORKS OF THE WEIR FROG COMPANY, CINCINNATI, OHIO.

few small machines taking power from a motor-driven shaft, every machine in the shop has an individual motor. An Ingersoll-Sergeant air compressor furnishes power for the riveters and for pumping water. An 8-in. 320-ft. artesian well supplies all the water used for boilers and other purposes. It is pumped by compressed air and stored in a 20,000-gal. tank, elevated 60 ft. above the ground. The floors of the boiler and filter room are 10 ft. below the level of the engine room and about 8 ft. below the grade level of the surrounding ground. Coal is received in hopper cars and dumped directly on the floor of the boiler room. Steam is supplied by four 250 h.p. Stirling boilers, equipped with American stokers. The well water is softened and filtered by the We-Fu-Go process, and is heated in a Webster exhaust steam heater.

At the end of the main shop building are two 2-story brick buildings 40 ft. by 60 ft. One is used for the general offices and drafting room and the other provides, on the first floor, for the workmen's wash and locker rooms, and on the second floor for the pattern shop and storage. Each of these buildings connects with the main shop by covered passageways.

With this fine new plant the company is admirably equipped to deal with its constantly increasing business.

## BOOKS AND PAMPHLETS.

Air Brake Tests. Compiled and Published by the Westinghouse Air Brake Company. In connection with its exhibit of braking appliances at the Louisiana Purchase Exposition, 1904.

This handsomely bound book of 323 pages (5 by 7 ins. in size) contains the history of the air brake in the United States as marked into periods of development by the series of well known brake trials which indicate the important turning points of improvement. It is therefore the most valuable and important work which has thus far appeared in connection with this subject. The scope of the book is indicated by the chapters, which are follows: Growth of Car Braking, Galton-Westinghouse Tests, Paris and Lyons Railway Tests, The Burlington Brake Trials, Westinghouse Freight Train Trials, Karner Trials, Sang Hollow Tests, Shiproad Tests, Nashville Locomotive Brake Tests, Absecon Tests, Atsion Tests. Each of these chapters represents an investigation for a specific purpose and each has marked a turning point in the advancement of the art of braking. Some of the test records have been published previously and some have not, but not even the most assiduous collector of air brake data has had all the facts which are recorded in this book. It is put in very convenient form and those who carry responsibilities of any kind in connection with train operation will need to study the book and keep it at

hand for reference. Inasmuch as the ability to stop trains safely limits the speed at which they may be run, the art of braking must not only keep pace with, but must advance ahead of, acceleration of schedules. At the present time the chapter on the high speed brake is the most important of the book, and is the one to which operating officers should give their attention. The Absecon tests on the Pennsylvania Railroad were undertaken in order to obtain reliable data of the stopping power of the high speed brake as compared with the ordinary quick-acting brake on passenger trains. Stops were made from speeds of more than 80 miles per hour and the high-speed brake was found to stop in about 26 per cent. less distance than the ordinary brake employing train-pipe pressures of 70 lbs. These trials also revealed the importance of higher pressures in additional storage capacity and they also indicated the importance of the locomotive truck brake as well as the vital necessity of maintaining locomotive, tender and car equipments up to the point of maximum service efficiency. It would be difficult to praise this book too highly.

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Technology of Paint and Varnish. By Alvah H. Sabin, John Wiley & Sons, 43 East 19th street, New York. Price $3.00.

The author aims to give a correct general outline of the subject of paints and varnishes, with a brief account of their modern use and of the principles which are involved in their manufacture and application. The first chapters are devoted to definitions and to an interesting account of the early history of paints and varnishes, and this is followed by a very thorough account of the modern methods of their manufacture and application. The subject, while treated in a technical manner, is arranged so that a layman can readily follow it.

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Loci in Mechanical Drawing. Part III. Piston acceleration. By Alec. MacLay. D. Van Nostrand Company, 23 Murray street, New York. Price $2.00.

Curves of velocity and acceleration are discussed and worked out in connection with piston motion in engine mechanism of the slider crank order.

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The Centrifugal Pump, Turbines and Water Motors. By Charles H. Innes. Fourth edition. D. Van Nostrand Company, 23 Murray street, New York. Price $2.00.

A treatise on the theory of turbines, centrifugal pumps and fans, specially adapted for engineers with a view to assisting them in designing such machinery.

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Poor's Manual.—Sample pages of the edition of January, 1904, have been received. This list will constitute a supplement to Poor's Manual of Railroads and will contain all important facts required by investors and others interested in bonded indebtedness. The compilation in preparation is the fourth annual volume. Poor's Manual for 1904 will be ready for distribution September 15 and will constitute a volume of 1,900 pages with 24 colored State maps and 50 maps of leading railroads. The statistics will show the great growth and relatively increasing importance of the electric traction systems as well as the progress of the steam roads. The volume for this year promises to be the most important and valuable issue of this indispensable publication.

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Falls Hollow Staybolts.—A leaflet issued by the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, presents eight strong claims made for these well known staybolts with explanations of the ways in which the hollow material meets them. These cover the elastic character of the hollow bolts, the relief of the fibers of the iron because of its form, the protection from burning, relief of the side sheets from stresses causing cracking, the admission of oxygen to the fire through the holes, the infallible warning of broken bolts, and long service of the bolts. The pamphlet closes with an extract from an article in *The Railway Age*, in which the advantages of these staybolts are outlined.

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Wire Rope.—The Broderick & Bascom Rope Company, of St. Louis, are distributing from their unique exhibit at the St. Louis Exposition a small pamphlet entitled, "Nothing New Under the Sun," so-called, because it shows a piece of wire rope taken from the ruins of Pompeii, and estimated to be 2,000 years old. It describes their exhibit, which shows in a very artistic manner the designs of rope made by them.

Machine Tools.—The Warner & Swasey Company, of Cleveland, are sending out a 1904 general catalogue which illustrates their hollow hexagon turret lathes, screw machines, turret lathes and other brass working machine tools.

Graphite.—September Graphite, published by the Joseph Dixon Crucible Company, is a special number and contains some excellent half tone illustrations of notable steel structures and some instructive articles on the preservation of metal surfaces.

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**The Cincinnati Machine Tool Company are now in their own building on Queen City avenue, Cincinnati, Ohio. The plant is thoroughly up to date in every respect, and is equipped with all modern facilities.**

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## NOTES.

The Walter A. Zelnicker Supply Company, St. Louis, reports the establishment of new sales offices at 1711 Tremont street, Denver, Col., and at 45 Dey street, New York City. The branch office at Seattle serves the extreme Western and Northwestern trade. Other branch offices are located in Mobile, New Orleans and Houston. The rail yard and warehouse are at East St. Louis, and the factory for maunfacturing the "double clutch" car mover is at New Madison, Ohio. Reports from the main office in St. Louis indicate that the coming year will bring the largest volume of business in the history of the company.

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Northern Electrical Company.—Contract has been awarded to this company for the entire motor equipment, about 450 h.p., for the new Southern Railway Company shops at Spencer, N. C., details of which were arranged under the direction of Mr. S. D. Cushing, signal and electrical engineer of that road. A combination of group and individual drive will be used, motor driven machine tools requiring variable speed to be equipped with 2-wire variable speed motors. They will also furnish a 50-kw. generator for lighting the shops at Alexandria.

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American Locomotive Equipment Company.—This company made an interesting exhibit of its specialties at the recent convention of the Traveling Engineers' Association in Chicago. They displayed the Sarver auxiliary exhaust valve, the Moone journal cellar, the Wade-Nicholson firebrick arch, Curran chime whistle, the Sarver automatic steam chest choke, and Northern metallic packing. The Sarver auxiliary exhaust valve is an appliance for relieving compression and back pressure. The Wade-Nicholson hollow arch is constructed of specially designed firebrick for effecting complete combustion. These features of the exhibits attracted special interest. On Thursday evening this company entertained the visitors in the large dining hall of the Lexington Hotel to the number of about 250 members and ladies. After a preliminary concert by a string orchestra four special vaudeville numbers were presented by comedians. Refreshments were served and a number of members addressed the assembly. The company was represented at the convention by Mr. Charles B. Moore, general manager; Mr. J. B. McMichael, secretary, and by Messrs. J. B. Bond, C. A. Crane, A. J. Stott and A. Munch.

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Roundhouse Heating.—Those interested in the construction of railway shops will find an article in the April issue of this journal, by R. H. Soule, particularly interesting in regard to roundhouses. Referring to the question of heating he said: "Heating by hot air from the fan is most satisfactory, especially if the dampers are so arranged that a large volume of hot air can be delivered under an engine in one pit and quickly thaw it out." This system of heating roundhouses is to be found throughout the country and especially in all the large roundhouses. By means of the fan, which is driven by a direct-connected steam engine, fresh air is drawn over the coils of steam pipes encased in a fireproof jacket and distributed through systems of distributing pipes, one overhead and another underground, the latter discharging the air under the engine and car-trucks for the purpose of removing the ice and snow from the engines and cars as they enter the roundhouse in the winter season. Among the recent installations of the fan heating system by the B. F. Sturtevant Company are those at the Wabash Railway roundhouses at St. Louis, Mo., and Montpelier, Ohio; the Pennsylvania roundhouse at Philadelphia, Pa.; the Illinois Central, Chicago, Ill.; the C., M. & St. Paul Railway, Galewood, Ill., and nine roundhouses of the Canadian Pacific Railway at North Bend, B. C.; Regina, Assa.; Sault Ste. Marie, Ont.; Cartier, Ont.; Webbwood, Ont.; Chalk River, Ont.; McAdam's Junction, N. B.; Outremont, P. Q., and Toronto Junction, Ont.

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J. McGregor Adams, one of the founders of the firm of Crerar, Adams & Company, and the head of the Adams & Westlake Company, died in Chicago September 17.